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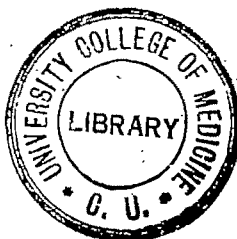
The
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AND RADIUM THERAPY

Editor: LAWRENCE REYNOLDS, M.D.

8

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diathermy by relieving the angiospasm led to improvement of the circulation and thus to arrest in the progress of the arteriosclerosis.—*T. Leucutia.*

ROENTGEN AND RADIUM THERAPY

MILANI, EUGENIO. Die Radiotherapie der entzündlichen Affektionen. (Radiotherapy of inflammations.) *Strahlentherapie*, 1932, 43, 401-440.

The history of the use of radiotherapy in inflammations is reviewed. Great progress has been made in this field in recent years. Most authors are agreed that small doses are to be preferred. The optimum dose is about 20 per cent of a skin erythema dose (120 German R units, about 260 French R and about $2\frac{1}{2}$ Holzknecht). Generally large fields are preferred with moderately strong filtration (5 mm. aluminum), less frequently 0.5 mm. zinc or copper is used with moderately hard radiation, 100-150 kv., 20-25 cm. focus-skin distance and 2 ma. Of course this scheme is varied to suit the individual case. Secondary radiation from metals introduced into the body by iontophoresis has been developed by Ghilarducci and his school in Italy and has given excellent results in many cases.

Irradiation is particularly effective in acute and subacute localized forms of inflammation. The inflammatory diseases in which irradiation has been used successfully are divided into general suppurative inflammations, inflammatory diseases of the teeth, bones and joints, inflammatory eye diseases, inflammations of the genital organs, bronchopulmonary diseases and diseases of the central nervous system. Technique and results in each of these groups are reviewed.

Better results are obtained by direct irradiation of the focus than by indirect irradiation. There are four factors to be considered in the local action of the rays: the effect of the local irradiation on the circulation, the necrobiotic action on the cells of the infiltration, the action on phagocytosis and the action on the reticulo-endothelial cells of the skin. In addition to the hyperemia which is the most striking visible effect of the rays, labile cells are destroyed and there is an active proliferation of the movable and fixed connective tissue cells. The observed facts seem to agree with Businco's theory that the doses of rays ordinarily used in inflamma-

tions not only increase the activity of the reticulo-endothelial system but also mobilize the histogenous wandering cells.—*Audrey G. Morgan.*

WINDHOLZ, FRANZ. Über die Strahlenbehandlung der Tonsillarhypertrophie zugleich ein Beitrag zur Strahlenatrophie der Tonsillen. (Roentgen therapy of hypertrophy of the tonsils and a study of the atrophy of the tonsils brought about by the rays.) *Strahlentherapie*, 1932, 43, 327-348.

It is quite generally agreed that roentgen irradiation brings about a decrease in the size of hypertrophied tonsils due to the fact that lymphadenoid tissue is particularly sensitive to the action of the rays. The difference in percentages of results reported by different authors is due to the fact that in some of the collections of statistics the majority of the patients were children and in children the lymphadenoid tissue has a much greater capacity for regeneration so that recurrence of the hypertrophy is more frequently seen. In the author's material the hypertrophy was overcome in 77 per cent of the adult cases and 57-60 per cent of the cases in children. The clinical symptoms begin to improve even before there is any visible change in the size of the tonsils. In acute inflammations pain and fever stop within two to three days. Deep inflammations are also affected. The author reports one case of recurrent angina and chronic recurrent nephritis cured by irradiation of the tonsils and another of joint rheumatism. The number of bacteria in the lacunae and crypts is decreased. Some forms of bacteria, particularly hemolytic streptococci and diphtheria bacilli, disappear completely in the majority of the cases.

A detailed description of the histological appearance of the irradiated tonsils is given and illustrated with photomicrographs. The atrophy affects all the tonsillar tissues, epithelium as well as lymphadenoid tissue.

A lateral field is irradiated over each tonsil and if adenoids are to be reduced two fields on the nape of the neck are also irradiated. About 3-4 H of heavily filtered radiation is given to adults and 2-3 H to children; filter 0.5 mm. zinc and 1 mm. aluminum, 170 kv., focus-skin distance about 30 cm. Both sides may be irradiated the same day or on successive days. This irradiation is repeated twice at intervals of three days and the series repeated after an

interval of three to four weeks. After six more weeks a third series of the same dosage is given. Of course there will be variations from this scheme in individual cases.—*Audrey G. Morgan.*

MORAWITZ, P., and SCHATZKI, R. Frühsymptome des Krebses. (Early symptoms of cancer.) *Strahlentherapie*, 1931, 42, 821-839.

The great majority of cancer patients still come for treatment too late for operation. Some progress has been made in early diagnosis, particularly by means of roentgen examination in cancer of the stomach and lungs. Roentgenograms are given showing pictures in early cases. But it still remains true that there are no early symptoms of cancer in the true sense of the word, that is, symptoms that show tumor in a stage when it is still local and operable. The patient generally does not come to the physician until it is too late or if he does come the symptoms are so indefinite and general that a diagnosis cannot be made.

There are only two possible ways of improving this situation. One is to find a specific cancer reaction comparable to the Wassermann reaction which is positive in the early stages and apply it to every elderly individual once or twice a year. It is impossible at present to say whether this can ever be attained. The other method, which seems more hopeful, is to find non-surgical methods of treatment of cancer, and among these radiotherapy seems to give the most promise.—*Audrey G. Morgan.*

BLUMENTHAL, FERDINAND. Die Organisation der Krebsbekämpfung. (The organization of the fight against cancer.) *Strahlentherapie*, 1931, 42, 809-820.

A great deal can be done to lower the mortality from cancer by organization of present resources without any specific cure for cancer. The author thinks the most important point is to induce patients to come for treatment early. Objections have been made to the propaganda for instructing the public in regard to the early symptoms of cancer as it is claimed that it gives the public a "cancer panic." But there is no way of instructing the public without making use of the press and while the articles published should be supervised by a physician, the doubtful and controversial scientific points must not be brought before the public but they must be told something positive and it is per-

fectly truthful to tell them that cancer can be cured if treated in the right way early enough. The idea that cancer is incurable is held quite generally not only by the laity but also by physicians and they also need instruction. The author has known of patients who went to charlatans because they were told by physicians that their disease was incurable, and there are many such cases. It is estimated that 60-80 per cent of the patients with female genital cancer now come for treatment in an inoperable condition. Certainly a large number of these patients could be saved by public instruction.

Courses should be instituted to keep physicians and students in touch with progress in cancer diagnosis and treatment. The practitioner cannot have all the technical means of diagnosis and treatment available himself but he should know where they can be obtained. There should be a center for cancer diagnosis and treatment in every province for there will always be cases which the general practitioner cannot be expected to diagnose and in many country districts and small towns there are no specialists capable of diagnosing cancer of the digestive tract, mouth, larynx, etc. Often even in larger hospitals there is only an internist and a surgeon, but no specialist in cancer.

Exploratory excision, if performed at all, should be done only by the surgeon immediately before operation.

Organization should not be carried too far but some control should be exercised over the practice of radiotherapy by private physicians. Those who have sufficient amounts of radium available and sufficient knowledge of the technique of radium and roentgen therapy should be allowed to continue practice but the centers should have large amounts of radium available and all cases requiring the use of such large amounts should be sent to the centers. There is only about 15 to 20 gm. radium in Germany and it is so divided up that only comparatively few places have enough for really effective treatment. A great deal of harm is done by private physicians practicing with inadequate apparatus, insufficient amounts of radium and insufficient knowledge of the subject.

The centers should also test new remedies proposed for cancer before they are allowed to be used on the public. A much disputed point is whether patients should be told that they have cancer. Generally every effort is made to

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VOL. XXX

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No. 1

KIENBÖCK'S DISEASE OF THE SEMILUNAR BONE OF THE WRIST*

By CARL L. GILLIES, M.D.
CEDAR RAPIDS, IOWA

KIENBÖCK in 1910 called attention to an isolated degenerative disease of the semilunar bone of the wrist, which presented a rather constant clinical picture and typical roentgen findings. He observed that while a history of severe injury to the wrist may be present, it does not seem to be essential, and the condition may follow an injury so slight as to have been forgotten, or one in which the immediate symptoms are not severe enough to prevent the patient from working.

Kienböck's observations were based on 20 cases collected from the literature, which had been reported either as compression fractures or accessory bones in the region of the semilunar, and 16 personally observed cases which he discussed from the standpoint of the roentgenologist.

Oddly enough, although the later stages of Kienböck's disease have a very characteristic and typical roentgen picture and, in fact, the preoperative diagnosis can only be positively made by roentgen examination, I am unable to find an original article on Kienböck's disease in any of the leading American journals devoted to our specialty. Although he reported no cases, first mention of Kienböck's disease in the English literature was made by Speed in his textbook published in 1916. Since that

time I have been able to find but 23 reported cases in this country. Fifteen have been reported in England and 2 in Canada. To these I wish to add 5 of my own. It is generally agreed, however, that the condition is more common than the reported cases lead one to believe.

Aside from the term, "Kienböck's disease," the names applied to the condition are almost as numerous as the essayists reporting cases and in part are as follows:

- Secondary post-traumatic malacia
- Lunate osteomalacia
- Traumatic atrophy
- Traumatic nutritional disturbance
- Traumatic osteoporosis
- Traumatic osteitis
- Chronic osteitis
- Aseptic necrosis
- Compression osteitis, etc.

Because the disease is not understood, the theories as to etiology are also numerous. They have been summarized by Riches as follows:

- (a) *Those assuming the presence of a fracture.*—
 1. Localized osteitis fibrosa in the region of a fracture (Wollenberg).
 2. Defective regenerative ability of the carpus (Baum).
 3. Aseptic primary bone necrosis with a pathological fracture (Axhausen).

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

(b) *With no assumption of fracture.*—

4. Injury to the blood-vessels, due to tearing of the dorsal and lateral ligaments following a momentary dislocation, and followed by rarefaction (Preiser). That this is probably incorrect was pointed out by Ogilvie when showing a case recently at the Medical Society of London. He had followed up cases of dislocated semilunar which were reduced, and none had developed Kienböck's disease.
5. Abnormal pressure due to anatomical anomalies (Müller).
6. Degeneration (Destot).
7. Infection (Fontaine).
8. Leriche assumes that there can be no rarefaction without hyperaemia, and suggests a traumatic axone reflex, the sequence being trauma, vaso-constriction vaso-dilatation, bone absorption.

Kienböck believed that any compression of the bone was not primary, but was secondary to a degeneration and increased fragility resulting from an injury to blood vessels during a momentary subluxation, a theory applied previously by Preiser to similar changes occurring in the carpal scaphoid, and comparable to changes found in Kummell's disease of the spine. Others have thought the condition comparable to the osteochondritides such as Perthes', Legg-Calvé's, Köhler's, Osgood-Schlatter's, etc. Against this belief is the fact that Kienböck's disease has always been found in adults, whereas the other group occurs in childhood or at least before the closure of the epiphyses.

INCIDENCE

In 45 cases which comprise the 25 reported North American, 15 English, and the 5 of my own, 37 occurred in males and 8 in females, a predominance in males of slightly over 4.5 to 1. The right wrist was involved 27 times to 11 times on the left. One case was bilateral, and in 6 cases the wrist involved was not stated, a predominance of involvement of the right wrist of nearly 2.5 to 1.

The age incidence varied from eighteen to sixty, approximately one-half occurring

between the ages of twenty to thirty, and three-fourths between the ages of twenty to thirty-five. Almost every case occurred in a person engaged in heavy manual labor.

PHYSICAL FINDINGS

Physical examination reveals in every case varying degrees of limitation of wrist motion in all directions. In the active stages of the disease, there is pain on movement, particularly on twisting or pushing. Swelling is usually present over both the dorsal and ventral surfaces of the wrist with tenderness to pressure over the semilunar bone. Finister (quoted from Goldsmith) states that two signs, if present, are almost pathognomonic. These are:

1. The head of the third metacarpal is on the same level as those of the second and fourth, while normally it is more prominent. This is, of course, due to partial absorption of the semilunar, allowing the third metacarpal to be retracted.
2. Pain localized over the semilunar bone on tapping the head of the third metacarpal with the fist closed and the hand in ulnar adduction.

ROENTGEN FINDINGS

The roentgen findings, after the development of the characteristic bony changes, offer the simplest method of positive diagnosis. Films of the affected wrist show an increase in density of the semilunar with loss of the normal bony trabeculations. Small wavy lines of rarefaction running in a transverse direction are usually present producing the appearance of fragmentation. The proximal articular surface is irregular and deformed, whereas the distal surface is smooth and of normal shape.

The lateral view is very important, and shows, in addition to the increase in density, a change in the contour of the bone. The normal crescentic shape is lost, the superior and inferior surfaces being more nearly parallel, with a resulting loss of volume. The roentgen findings are unchanged years afterward. The appearance of the bone seems to bear no relation to the patient's subjective symptoms.

conceal the fact from them but this would no longer be necessary if the disease was not considered hopeless. Patients do not seem to object to going to the "Polyclinic for tumor patients" in Berlin and many of them seem to be glad that there is a place where they can get treatment from physicians with special knowledge and skill in such diseases.

Care must also be provided for the hopeless cases. They are now frequently rejected by hospitals because they are long drawn out and expensive cases to treat and are repulsive to the other patients in the ward and make them feel hopeless. There should be special hospitals or wards in connection with the centers for taking care of them.

The author does not advocate systematic examination of the whole populace for cancer. Some cases of cancer of the uterus have been discovered in America by examination of symptomless cases but it is almost impossible to give a patient a bill of health in regard to cancer of the digestive tract, for instance. The best that can be done is to keep him in the hospital for a week and subject him to expensive examinations and tell him that nothing has been found. That does not prove that he is free of cancer. Nor does the author believe in the compulsory reporting of cancer. That should be required only in diseases that endanger the public and cancer does not.—*Audrey G. Morgan.*

BÖHMERT, W. Die Todesfälle an Krebs nach dem Alter 1901–1930. (Deaths from cancer according to age, from 1901 to 1930.) *Strahlentherapie*, 1931, 42, 971–984.

Statistics are given for cancer deaths by age in different regions in Germany and an attempt made to draw some general conclusions from them in regard to whether cancer is really increasing. The author concludes that the increase in the number of deaths from cancer in Germany as a whole is almost entirely due to the fact that the average length of life in Germany has been increased in this period by almost twenty years and therefore much larger numbers of people reach the cancer age. A careful examination of the statistics in the regions where the causes of death are determined most carefully (Bavaria, Baden, Hamburg, Bremen, Berlin) shows that up to 1925 (the date of the last census) there has been no comparative increase but rather a decrease of

cancer in all except the highest age group from sixty to seventy. The increase in this group is probably due to the fact that in former years old people of the poorer classes, particularly in the country, rarely had medical treatment.

Though the total statistics for Germany as a whole and particularly Prussia show a comparative increase, it is probable that in many parts of North Germany in former years many cases of death from cancer were attributed to senile weakness, ulcer of the stomach, etc. The most recent statistics for some districts (Hamburg and Bremen) seem to show that there has actually been an increase since 1925.

The following suggestions are made in regard to the collection of international statistics on cancer deaths. The deaths from cancer should be arranged according to decades and sex and compared with the total number of living individuals of the same age group. The next census should be utilized and the average number of deaths for that year and the two years before and after it calculated in proportion to the total number of living individuals in the census year. For a yearly comparison of the figures for the different countries the whole number of cancer deaths should be compared with the whole number of living persons over thirty years of age. The cancers should be classified according to the organs from which they originate. Only carcinomas and sarcomas should be counted as cancers. It is important in studying the causes of cancer to have the cases classified according to the regions from which they come. Patients dying in city hospitals should be classified in the district in which they live. The number of cures as compared to the total number of deaths should be calculated and also the causes of death in all members of the family. Questionnaires should be sent to patients treated for cancer and after the case is closed the answers should be sent to the public health authorities and evaluated statistically.—*Audrey G. Morgan.*

ROOSEN, RUDOLF. Zur Krebsprognostik. (Prognosis of cancer.) *Strahlentherapie*, 1932, 43, 188–189.

The effect of radiotherapy is brought about partly by stimulating the defensive forces of the surrounding tissues. Therefore, the more of the surface of the tumor in proportion to its mass is in contact with normal tissue, the more effective the rays will be. A tumor that is grow-

ing into the lumen of a hollow organ and has only a small surface in contact with normal tissue is much harder to affect than an infiltrating one which is surrounded on all sides by normal tissue. These facts should be taken into consideration in the prognosis of cancer. This helps to explain the good results of isamin blue treatment reported by Wehik in cancer of the stomach, for he mentions the fact that these were all infiltrating tumors of the stomach wall.

For this reason, too, in inoperable tumors all parts of the tumor that are not accessible to the action of the local defensive forces should be removed by operation, that is, these tumors should be changed in form so that they have the greatest possible surface in proportion to their mass in contact with normal tissue.—*Audrey G. Morgan.*

- v. HABERER, H. Die Bedeutung der chirurgischen Behandlung für die Bekämpfung des Krebses. (The value of surgical treatment in the fight against cancer.) *Strahlentherapie*, 1931, 42, 840-857.

The author reviews the results of surgical treatment in the different forms of cancer and describes illustrative cases of various kinds of cancer. He concludes that the results are not satisfactory and every effort must be made to improve them. Among the 10,035 radical operations that he has performed 1,277, or 12.5 per cent, have been for cancer. Barely 50 per cent of these were radically operable. Palliative operations had to be performed in the rest. In many of these cases there had been only slight general or local symptoms. He doubts the advisability of publicity on the subject of cancer as he thinks it will only alarm the people.

One reason why so many carcinomas are inoperable when they come to the surgeon is that they are incorrectly diagnosed at first by the practitioner. Post-graduate courses do not help the situation much. They are generally taken by the older men; the younger ones are too busy with the struggle for existence to take them. The instruction should be given while they are still students. All the early symptoms and methods of early diagnosis should be taught in medical school and the state examination should be made stricter. He cites two cases of bleeding nipple and one of painless afebrile inflammation of the skin (carcinomatous lymph

gland infiltration) that were sent him by a colleague in a small town. He made a diagnosis of carcinoma and advised operation in all three; histological examination confirmed his diagnoses. If all insurance physicians made careful and minute examinations many such cases would be detected. The university clinics and the large hospitals can be used for consultation purposes.

Too much value is attached to negative roentgen findings. While there is no doubt of the great value of roentgen diagnosis all the clinical evidence should also be considered in negative cases. However unsatisfactory exploratory operation and excision is, it is sometimes necessary, particularly in carcinoma of the stomach.

Physicians can combat the tendency of patients to go to charlatans only by establishing greater confidence in the medical profession. Surgical treatment of so-called precancerous conditions is important in improving surgical statistics. Callous ulcers of the stomach and intestine and polyps of the large intestine frequently degenerate into cancer.

Further improvement can be brought about by changes in technique. For example, the author formerly resected carcinomas of the large intestine in one stage but he has found that the danger of the operation can be decreased by establishing an artificial anus above the intestinal suture. All technical improvements should be reported before the congresses and medical societies and as a matter of fact many carcinomas are now operated on radically that would have been considered inoperable twenty-five years ago.

Electrosurgery is a great technical improvement. The author has not yet dared to use it in stomach and intestinal operations. After electrocoagulation there is danger of secondary hemorrhage. This too may be overcome by improvements in technique. After-treatment is of great importance, particularly in carcinoma of the stomach. Diet, arsenic and in many cases insulin are valuable. He is not an enthusiast in regard to either preoperative or postoperative roentgen therapy though he acknowledges that he had a case of inoperable carcinoma of the breast rendered operable by radiotherapy. He operates on recurrences and metastases if they are operable; otherwise he uses radiotherapy and has often had good results, particularly in gland metastases.—*Audrey G. Morgan.*

It is said that films taken immediately after the onset of symptoms may show no demonstrable roentgen changes, but in those cases which develop following a history of adequate trauma, fracture lines may sometimes be seen. Unfortunately, as in all of my cases, the taking of roentgenograms is likely to be delayed, due either to the mildness of early symptoms or the lack of objective findings, which often leads the attending physician to suspect malingering.

TREATMENT

Of the 40 cases reported in England and America, slightly over half have been operated upon. In this group the first operations were reported by Rogers in 1921 and 1922. The results of complete excision of the bone appear to be satisfactory. Although some limitation of motion is almost sure to result, pain is relieved and a good functional wrist is usually obtained, the patient being able to resume heavy work in a comparatively short time. Early operation also lessens the possibility of the development of a traumatic arthritis.

Under non-operative treatment consisting of splinting, etc., in only 4 cases (Undine, Riches, and in Cases III and IV of this series) has there been almost complete functional recovery, and except for Case III only after several years of disability. As most of the cases have not been followed for this long or the ultimate results have not been reported, it is reasonable to expect a somewhat larger percentage of symptomatic recoveries.

When one considers the number of failures following a long period of expectant treatment, in a class of people depending upon the use of their hands for a livelihood, it would appear that early operation is the treatment of choice.

PATHOLOGY

Several specimens removed at operation have been examined microscopically. A typical report reads as follows:

"Microscopic sections of the lunatum showed central necrosis and breaking down of bone by

fibroblastic tissue with considerable absorption of cartilage. There was practically no leukocytic infiltration. In some regions there was extensive regeneration of bone and cartilage. The process of transformation was one of absorption and replacement of the dead bone by fibroblastic tissue which in turn was being replaced by new fibroblastic tissue, which in turn was being replaced by new bone formed

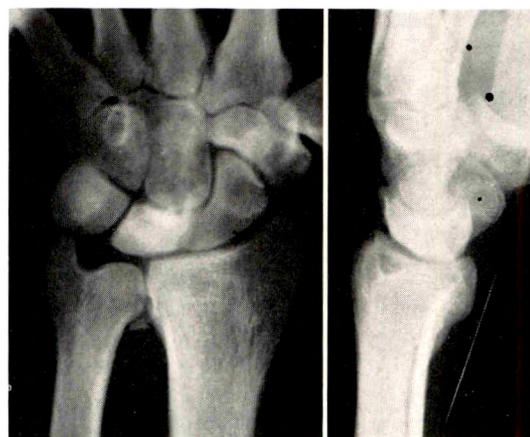


FIG. 1. Case I. Sclerosis and irregular outline of semilunar bone.

from surviving old bone rather than one of creeping substitution of dead bone by new as occurs extensively in the organization of areas of aseptic necrosis." (Phemister, et al.)

INDUSTRIAL AND MEDICOLEGAL ASPECT

Since Kienböck's disease occurs almost always in persons engaged in heavy manual labor, the medicolegal aspect and the question of compensation are important. A large share of the responsibility of determining the duration of the disease rests in the hands of the roentgenologist, whose opinion must be based upon the amount and character of the bony changes present. A pitfall to be avoided is assuming that a recent injury has been solely responsible for the production of the disease, whereas actually it may have been pre-existing, and the recent injury has only served to aggravate the symptoms or focus attention on an already damaged wrist.

While in a certain number of cases no

history of adequate trauma can be obtained, trauma undoubtedly plays a very important part in its production. In about

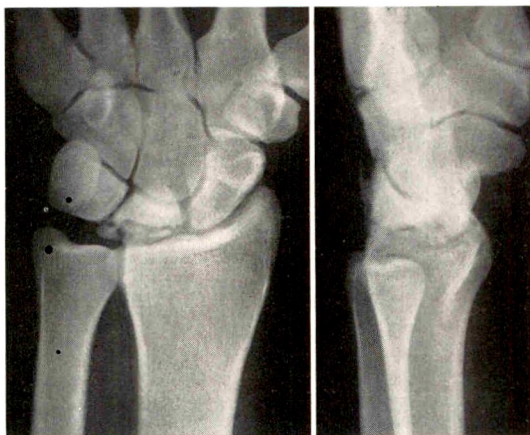


FIG. 2. Case 11. Sclerosis, wavy transverse lines of lessened density, and loss of volume of semilunar bone.

one-third of the 45 cases reviewed, a history is recorded of the onset of symptoms following a single acute dorsiflexion injury to the wrist. Others give a history of onset following a blow to the back of the wrist or directly on the closed fist, the force being transmitted through the metacarpals. My personal views are in general accord with those of Müller (quoted from Köhler), who lays the blame on compression injuries.

"Three forms are said to occur:

- (1) In the anatomically conditioned forms a pathological process of the semilunar is brought about by the special and abnormal anatomical conditions."

Obviously this group has no relation to the type of occupation, and should not be compensated.

- (2) "In the 'professional' forms continual small compression injuries in special occupations (especially agriculture) are blamed as the cause."

It would appear that the repeated minimal trauma is the direct result of the character of the occupation, and, therefore, this group is entitled to compensation.

- (3) "In the traumatic form a single compression injury can elicit the disease. The latter runs its course in three stages and this is pathognomonic: first a short stage of slight articular irritation, then a stage of relative absence of symptoms, several months in length, finally a definite stage of disease with severe manifestations."

This type seems to offer the least difficulty in determining the responsibility of the employer, and if the injury occurred during the course of duty, the patient is deserving of compensation.

The infectious theory as a causative factor cannot be ignored. One group of observers (Phemister et al.) in a controlled experiment, under very strict aseptic precautions, were able to grow long chain streptococci in 2 instances in which the semilunar bone was removed by operation.

In the following 5 cases of my own, the histories were obtained from the patients at the time of their second roentgen examination, which in most instances was several years after the onset of symptoms. For that reason the time as recorded between the onset of symptoms and the tak-

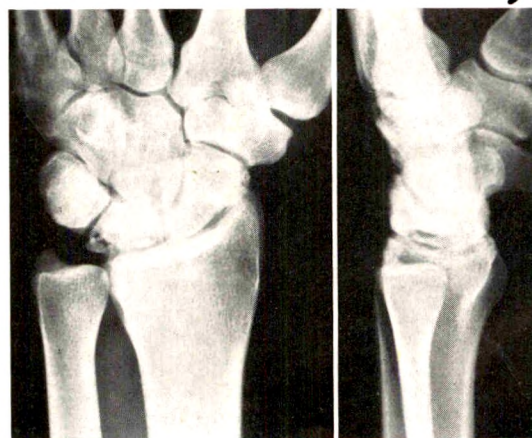


FIG. 3. Case 11. Four years later, showing little change in appearance.

ing of the first roentgenograms may not be accurate.

CASE 1. E. M., male, aged twenty-one, baker.

On January 3, 1930, the patient was struck on the back of the right wrist with the dump

crank of a dough mixer. Although the wrist was painful, he continued working, and a doctor was not consulted for two weeks. At this time malingering was at first suspected because of the absence of objective findings. On January 24, 1930, a roentgenogram (Fig. 1) was made which shows a loss of normal bony trabeculations, an increase in density, and an irregularity in the outline of the semilunar. This irregularity is seen best in the lateral view.

The wrist was immobilized in plaster-of-Paris with only temporary relief. When last seen by the attending physician on May 21, 1932 (two years after the original injury), there was still limitation of motion with pain in the extremes of motion, and tenderness to pressure over the semilunar.

CASE II. N. L. M., male, aged twenty-five, laborer.

In 1928 a truck that the patient was cranking, backfired, injuring his right wrist which remained "lame" for three weeks. About two weeks later the wrist was again injured in the same way.

A roentgenogram (Fig. 2) taken at this time shows a sclerosis and loss of volume of the semilunar with transverse wavy lines of lessened density in the proximal half of the bone.

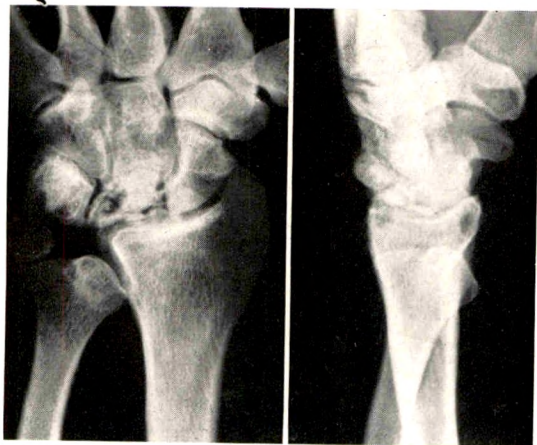


FIG. 4. Case III. Sclerosis, irregular areas of lessened density and loss of volume of semilunar bone. The deformity of both bones of forearm and shortening of ulna with fracture of styloid process are the result of an old injury.

The patient was seen again in July, 1932 (four years later), and a film (Fig. 3) shows very little change in the appearance of the semilunar.

Examination shows limitation of wrist motion in all directions with pain in the extremes. There is tenderness over the semilunar

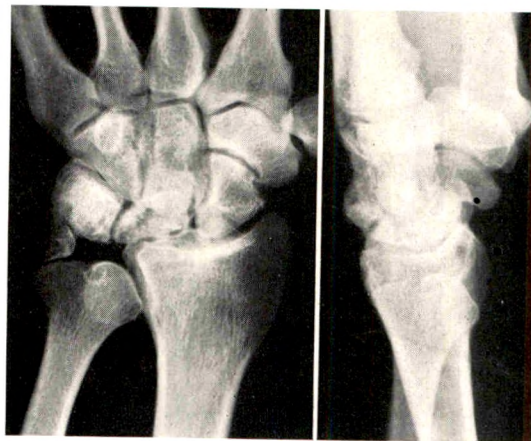


FIG. 5. Case III. Two and one-half years later, showing little change in appearance. There is no history of disability.

on pressure. The patient says he is able to lift heavy objects, but any twisting of the wrist causes sharp pain followed by a dull ache in the wrist.

The wrist has been splinted many times with but temporary relief. The patient is unable to do ordinary labor because of his wrist, and has lost his job as a consequence.

CASE III. R. W. W., male, aged forty-two, locomotive engineer.

A routine physical examination on October 27, 1929, showed a slight limitation of motion of the right wrist in all directions. There were no subjective symptoms and the patient was unaware that there was anything wrong. He gave a history of having fractured both bones of the right forearm at the age of ten.

A roentgenogram (Fig. 4) shows anterior bowing of the radius, posterior bowing and shortening of the ulna, obviously a result of the childhood injury. There is an old fracture of the styloid process of the ulna, and the semilunar shows general sclerosis with small irregular areas of rarefaction and a loss of volume.

A film (Fig. 5) made in July, 1932 (2½ years later), shows no change in appearance.

I believe this case falls into the anatomical conditioned group, and is similar to one shown by Müller. Both show shortening of

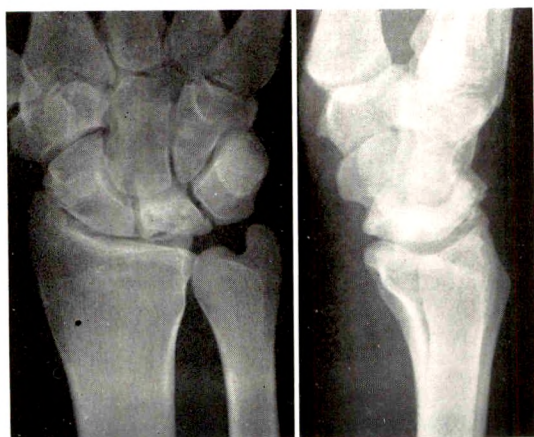


FIG. 6. Case iv. Sclerosis, loss of volume and wavy transverse lines of lessened density of the semilunar bone.

the ulna allowing additional stress and strain to fall on the semilunar.

CASE IV. Male, aged thirty, laborer.

In the latter part of 1923, the patient slipped and fell forward, striking the open palm of the right hand on the ground. He immediately experienced pain in the wrist, but was able to continue work. The wrist was kept bandaged for several weeks with but little improvement.

A roentgen examination (Fig. 6) on December 17, 1923, shows loss of volume of the semilunar, sclerosis and transverse wavy lines through the proximal half of the bone. No further treatment was given. The wrist was subject to twinges of pain for four or five years, but

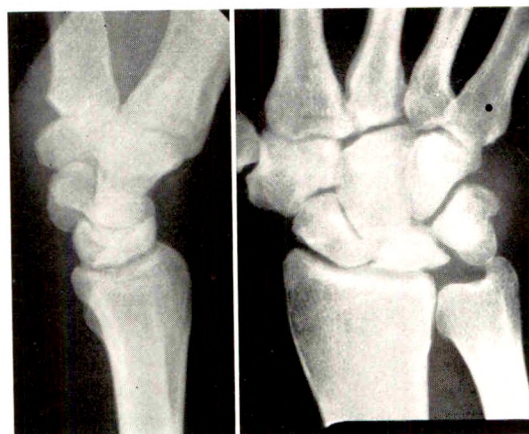


FIG. 8. Case v. Increase in density, loss of volume and flattening of the proximal surface of the semilunar bone.

for the last four or five years has been entirely free from pain.

A film (Fig. 7) made in June, 1932, or nearly nine years later, shows an increase in the sclerosis, but no change in size. Examination of the wrist shows slight limitation of motion in all directions but no subjective symptoms.

CASE V. U. V. R., male, aged twenty-eight, laborer.

The patient gives a history of having sprained his right wrist many times previously, but always with complete recovery. He dates the onset of the present symptoms to a twisting injury to his right wrist sustained while lifting a one hundred pound sack. The symptoms did

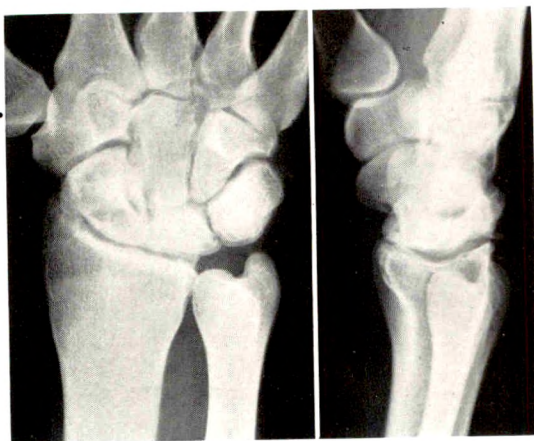


FIG. 7. Case iv. Nine years later shows an increase in density of the bone.

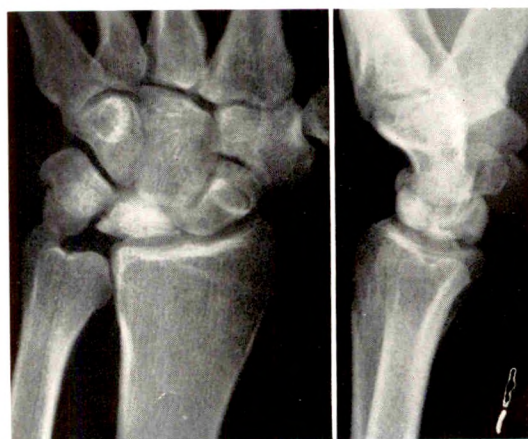


FIG. 9. Case v. One month later. Shows in addition a vertical fissure seen in the lateral view.

not improve so he consulted his doctor three weeks later, on August 6, 1932.

Examination at this time showed limitation and pain in the extremes of motion with tenderness over the semilunar to pressure. A roentgenogram (Fig. 8) shows a moderate increase in density, loss of volume and flattening of the superior surface of the semilunar.

The patient was seen as recently as September 5, 1932. There has been no improve-

ment of symptoms. He is still working and is able to lift, but twisting and lateral pressure cause severe pain. His duties include the signing of receipts, several carbon copies being made at one time. He is unable to do this because of pain from lateral pressure.

A film (Fig. 9) at this time shows very little change in appearance from the film of one month ago.*

* For discussion see page 49.

REFERENCES

1. BLAINE, E. S. Lunate osteomalacia. *J. Am. M. Ass.*, 1931, 96, 492-495.
2. BUCHMAN, J. Traumatic osteoporosis of the carpal bones (including Kienböck's disease.) *Ann. Surg.*, 1928, 87, 892-910.
3. BUTLER, W. S. Lunate osteomalacia or Kienböck's disease. *Canad. M. Ass. J.*, 1932, 26, 710-711.
4. CARY, N. A., and BARNARD, L. Kienböck's disease; compression osteitis of semilunar or lunate bone of wrist; report of cases. *Calif. & West. Med.*, 1931, 34, 36-40.
5. DESTOT, E. Injuries of the Wrist: A Radiological Study. Translated by F. R. B. Atkinson. Paul B. Hoeber, Inc., New York, 1926.
6. EVANS, E. L., and FAIRBANK, H. A. T. Two cases of Kienböck's disease. *Proc. Roy. Soc. Med.*, 1929, 22, 1459-1461.
7. FONTAINE, R. Traumatic atrophy of semilunar bone (Kienböck's disease). *Rev. de chir.*, 1925, 63, 769-775. Abs. in *J. Am. M. Ass.*, 1926, 86, 1402.
8. GOLDSMITH, R. Kienböck's disease of the semilunar bone. *Ann. Surg.*, 1925, 81, 857-862.
9. HENDERSON, M. S. Chronic osteitis of the semilunar bone (Kienböck's disease). *J. Bone & Joint Surg.*, 1926, 8, 504-506.
10. KIENBÖCK, R. Ueber traumatische Malazie des Mondbeins und ihre Folgezustände: Entartungsformen und Kompressionsfrakturen. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1910-1911, 16, 77-103.
11. KÖHLER, A. Röntgenology. Wm. Wood & Co., New York, 1928.
12. KURLANDER, J. J. Chronic osteitis of semilunar bone (Kienböck's disease). *Ohio State M. J.*, 1927, 23, 303-304.
13. MOUAT, T. B., WILKIE, J., and HARDING, H. E. Isolated fracture of carpal semilunar and Kienböck's disease. *Brit. J. Surg.*, 1932, 19, 577-592.
14. MÜLLER, W. Ueber die Erweichung und Verdichtung des Os lunatum, eine typische Erkrankung des Handgelenks. *Beitr. z. klin. Chir.*, 1920, 119, 664-682.
15. PATTERSON, W. J. A case of Kienböck's disease. *Canad. M. Ass. J.*, 1931, 25, 77-78.
16. PHEMISTER, D. B., BRUNSWIG, A., and DAY, L. Streptococcal infections of epiphyses and short bones. *J. Am. M. Ass.*, 1930, 95, 995-1002.
17. RICHES, E. W. Case of Kienböck's disease; ultimate recovery without operative treatment. *Lancet*, 1929, 2, 1189-1190.
18. ROGERS, M. H. Traumatic osteitis of the wrist. *Surg. Clin. N. America*, 1921, 1, 697-701.
19. ROGERS, M. H. Traumatic osteitis of wrist. *Boston M. & J.*, 1922, 186, 730-733.
20. SAUPE, E. Traumatic nutritional disturbance in semilunar bone. *Beitr. z. klin. Chir.*, 1923, 128, 187-196. Abs. in *J. Am. M. Ass.*, 1923, 80, 1185.
21. SONNENSCHNIG, H. D. Kienböck's disease of semilunar bone. *M. J. & Rec.*, 1927, 126, 18-19.
22. SPEED, K. Text-Book of Fractures and Dislocations with Special Reference to their Pathology, Diagnosis and Treatment. Lea and Febiger, Philadelphia, 1916.
23. UNDINE, C. A. Chronic osteitis of semilunar bone with history of case (Kienböck's disease). *Journal-Lancet*, 1928, 48, 340.
24. VANA, A. Aseptic necrosis in semilunar bone. *Cas. lek. cesk.*, 1925, 64, 985-992. Abs. in *J. Am. M. Ass.*, 1925, 85, 786.
25. VAN VALKENBURG, F. W. Kienböck's disease; report of case. *Minnesota Med.*, 1928, 11, 181-183.
26. VOSHELL, A. F. Kienböck's disease; report of a case. *South. M. J.*, 1930, 23, 321-323.
27. WEBB, R. C. Kienböck's disease of semilunar bone. *Ann. Surg.*, 1926, 84, 763-765.



TRAUMA AS AN ETIOLOGICAL FACTOR IN THE PRODUCTION OF DISEASES OF THE CHEST*

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ST. LOUIS, MISSOURI

IN THIS day of intensive industrial activity all types of injury have assumed great importance. The respiratory system is a complicated apparatus which carries with it the hazard of many other complications not associated with injuries in other regions of the body. The large serous-lined pleural cavity offers hazard of infection if it is penetrated from without; the normal negative pressure in the pleural cavity essential to respiration can easily be lost by penetration of the chest wall from without or puncture of the lung from within; the lung itself, an elastic body expanding and contracting with each respiratory cycle, is filled with numerous bronchioles and air sacs, yet is separated from the pleural cavity only by a thin delicate pleural membrane which can be easily ruptured, and, above all, the respiratory function, which is dependent on so complicated an apparatus, is essential to life. All of these things conspire to give injuries to the chest an importance which other injuries do not possess.

Injuries to the chest may be properly considered under the following headings:

- (1) Effects caused by trauma from without—external violence.
 - (a) Contusions of the chest wall.
 - (b) Fractures of the bony framework.
 - (c) Penetrating wounds of chest—stab wounds and gunshot wounds.
- (2) Effects produced by trauma from within—internal injury.
 - (a) Changes in intrathoracic pressure—rupture of lung with spontaneous pneumothorax.
 - (b) Aspiration of foreign bodies—laceration of lung structure; bronchial occlusion.
 - (c) Instrumentation, bronchoscopy.
- (3) Trauma as a factor in the production of bacterial diseases of the lungs and pleurae.

The most common effect of trauma applied to the chest is contusion of the chest wall and fractures of the bony framework, especially of the ribs. Ordinarily contusions of the chest wall cause no damage to the respiratory organs whatever, but occasionally pneumothorax may result with accompanying collapse of the lung. This may occur without even a mark being left on the chest wall. Where a rib is fractured and the lung punctured, this is easy to understand, but where pneumothorax occurs without fracture of the ribs it is more difficult to explain. Several such cases have been noted where an automobile has passed over the chest of an individual causing pneumothorax without fracture of the ribs or any evidence of trauma to the chest wall. A rather extreme example of pneumothorax without attendant fracture of the ribs was noted in a patient who in suicidal attempt jumped from the St. Louis Municipal Bridge and struck the water surface 125 feet below, flat on his left side. There were no fractured bones, but he suffered pneumothorax on the left side with complete collapse of the lung; ecchymosis of the entire left side of the body was present. A second person who some months later jumped from the same bridge suffered similar injury. If pneumothorax occurs from such a type of injury it occurs immediately and the collapsed condition of the lung can be demonstrated at once. In such cases the lung soon heals and the air is rapidly absorbed; complete recovery usually results within three or four weeks. Unilateral pneumothorax is not so serious; bilateral pneumothorax, however, is very serious and may result in death.

Dry pleurisy with thickening of the parietal pleura over the injured area may result from trauma applied to the chest

* From the Radiology Department of St. Mary's Hospital and St. Louis City Hospital. Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

wall, either with or without fracture of the ribs. In such instances unattended by fracture of ribs the symptoms often are not pronounced until three or four days or a week after injury, when a sharp knife-like pain develops in the involved area on deep inspiration. The area involved is usually limited to the region of trauma. We have never had in our experience any instance in which this type of pleurisy did not subside with proper strapping within a few days or weeks without subsequent ill effect. Pleural effusion rarely supervenes and we have never seen empyema develop from external trauma where the chest wall has not been penetrated. Roentgenographically a localized thickening of the pleura can be noted over the area involved; the appearance is not in any respect different from thickening of the pleura from other cause.

Free hemorrhage into the pleural cavity usually does not occur unless there has been actual fracture of a rib or penetration of the chest wall by some instrument. Blood does not seem to have the same tendency to clot in the pleural cavity that it ordinarily possesses elsewhere in the body, and bleeding may continue for a long time. Clotting of blood in the chest does occur, but it is often delayed and bleeding may continue for days. The roentgenographic manifestations of hemothorax are in most respects similar to those seen in other types of fluid; occasionally where there is no associated pneumothorax, however, the appearance immediately after the injury may be that of a general haziness over the entire chest rather than an increase in density possessing the characteristic upper curved line of fluid. This is probably due to the fact that in the early stages the blood has spread itself out in a thin layer between the lung and chest wall. It is not sufficient, therefore, if no manifestation of pleural hemorrhage is noted at roentgenographic examination immediately after injury, to conclude that the danger from this cause can be eliminated; subsequent roentgenographic examinations must be made. Fluid

blood remaining in the chest for a long time undergoes chemical changes and becomes a dark chocolate color. These chemical changes release protein substances which in their new forms are foreign to the body and provoke a sensitization reaction. Continuous high fever for a period of days or weeks

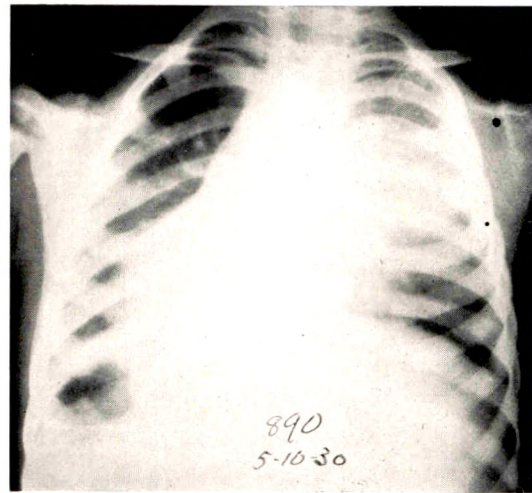


FIG. 1. Traumatic pneumonia in child following five days after fall from highchair. The site of consolidation in right side is over the site of injury. There was no contusion or laceration visible on the chest.

may lead to the belief that infection has occurred, whereas the fever may only be due to the sensitization reaction. Under these circumstances aspiration of the fluid will terminate the fever and result in complete recovery. We have not seen in our experience any lasting or disabling results following hemothorax where infection was not present.

Hemorrhage into the surrounding interstitial tissues of the lung from injury to this organ is a frequent occurrence, especially where the injury is extensive and there are multiple fractured ribs. The roentgenographic appearance is one of a blotchy irregular area of increased density without well-defined margins, usually involving the lower lung fields. This may be associated with hemoptysis, dyspnea and pain in the chest. The patient is usually in extreme shock. These roentgenographic

findings are usually present immediately following severe injuries. They may be attended by bleeding into the free pleural cavity. This condition is rarely associated with pneumothorax and if the patient recovers from the immediate shock, resolution most frequently takes place with complete restoration to normal, often without producing ill effect or without leaving any manifestation in the roentgenogram after recovery. Where interstitial hemorrhage occurs as a result of penetrating wounds such as stab wounds, gunshot wounds, etc., the characteristic appearance may not be shown at once, but may require a few hours to develop.

Ordinarily, penetrating wounds of the chest cannot be considered as extremely serious if infection does not supervene. In an analysis made a few years ago at St. Louis City Hospital⁷ of stab wounds and gunshot wounds of the chest it was found that in a series of 135 cases of gunshot wounds treated at the Hospital during a five-year period, 58 proved fatal, largely because of associated injury to the abdomen, skull or spinal cord. Only 4 of the fatal cases were from lung involvement alone, and in all of these the wound was in the upper chest, or traversed both lungs from side to side. In the first patient the wound was located in the episternal notch; in the second, it was through the sternoclavicular joint; in the third, the wound was in the upper lobe, and in the fourth, the wound was in the axilla, traversing the chest from side to side. It is probable that these cases were attended with mediastinal involvement, since vomiting of blood was a prominent symptom. If one lung alone is involved, and the injury is not extensive, recovery can be expected in a large percentage of cases.

In a series of 108 stab wounds of the chest treated at the St. Louis City Hospital during the same five-year period, 11 proved fatal. Death in these instances likewise was due to associated injury to other organs, especially the heart and abdominal organs. One instance occurred in which

death was probably due to hemorrhage from an intercostal artery, since no evidence of injury to the lung could be found at autopsy. When a stab wound is confined to the lung and is unassociated with injury to the heart or abdominal organs, recovery can be expected in a very large percentage of instances. When recovery occurs, it is usually complete and healing takes place with little if any disability. There is usually no demonstrable sign in the roentgenogram.

From an analysis of this series of cases it was also found that there is very little likelihood of infection being carried into the chest by injuries from without, even where there has been complete penetration of the chest wall with injury to the pleura and lung, "since in only three instances in a total of 174 patients who survived, following penetrating gunshot wounds and stab wounds of the chest, did empyema subsequently develop; once following a gunshot wound and twice following stab wounds."

If infection of the lung does occur the resulting abscess has the characteristic appearance of abscess from other cause and carries with it the same grave prognosis as to life and ultimate recovery of function. We have seen only a few instances in which abscess of the lung was caused by trauma from without; these were due to direct inoculation of infection by penetrating wounds and never to trauma, even when extreme, in which the chest wall was not penetrated. In only one condition does bacterial disease of the lungs seem to follow trauma in a few instances; this is in so-called "traumatic pneumonia" which will be discussed more fully later.

One rather peculiar condition of doubtful etiology which follows trauma to the chest and even remote portions of the body is massive atelectasis. This is a condition in which the lung, previously well expanded and functioning normally, suddenly, without apparent cause, loses its air content and becomes atelectatic. The loss of air content causes the lung to become smaller

than when previously expanded and, since there is no attendant pneumothorax, the side of the chest affected becomes narrower—the interspaces show closer approximation; the heart and mediastinal structures are drawn over to the affected side and the diaphragm becomes elevated and immobile on the affected side. The collapsed lung shows a density fully as great as pneumonic consolidation. This condition may follow direct injury to the chest or other remote portions of the body. It is most frequently encountered as a post-operative complication after abdominal operation. The condition is disabling for a time, but is rarely fatal and on re-expansion of the lung, complete function is re-established without any subsequent ill effects.

Trauma from within is more limited in its variety of effects. Obviously any effect which changes the intrathoracic pressure will place a strain on the lung. This can cause rupture with spontaneous pneumothorax and collapse of the lung. Heavy straining or lifting may produce this condition in a lung which shows no evidence of previously existing disease. At times this follows seemingly trivial exertion; it may be accompanied by sudden pain in the chest and shoulder extending down the

arm; there may be accompanying dyspnea if the collapse is pronounced. With rest, the lung heals and the air is absorbed by the circulating blood. We have seen a number of instances in which pneumothorax of

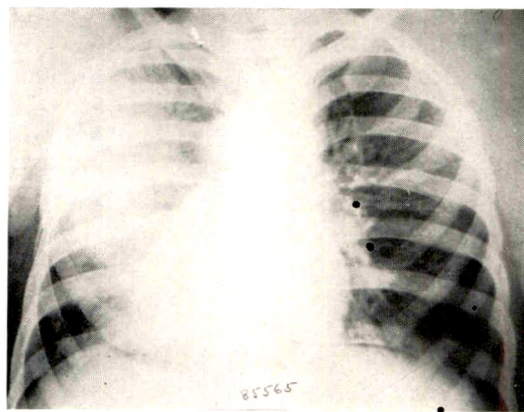


FIG. 2b. Traumatic pneumonia. Roentgen examination of same patient three days later showing development of massive pneumonic consolidation in left chest. The disease developed in the region receiving the trauma. Course and resolution were uneventful.

this type recurred at intervals without apparent pulmonary disease. The condition is probably due to rupture of an emphysematous pleural bleb. A period of absolute bed rest for one month has resulted in complete healing and restoration to normal.

Another form of injury from within results from aspiration of foreign bodies. Sharp irregular foreign bodies may cause injury to the lung either from their entrance or during instrumental attempts at removal. Such injury is usually manifested as pneumothorax similar in all respects to pneumothorax from other causes. With removal of the foreign body, if infection does not occur, the air in the pleural cavity becomes absorbed and re-expansion results.

The irritation incident to inhalation of dusts and gases is not included in this discussion, since they represent more the effect of irritation than actual injury.

The next question to be considered is one of great importance: What effect has trauma on the production of bacterial dis-

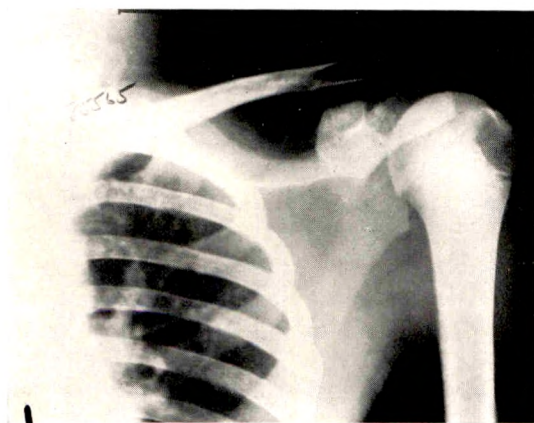


FIG. 2a. Left shoulder of boy taken shortly after falling down. No evidence of fracture. Adjacent lung field is clear. No contusion or laceration was visible in this region.

ease? Obviously this is a question very difficult to answer with any degree of accuracy. Reliance must necessarily be placed upon a history of trauma which is only too frequently inaccurate and uncertain. Only by prolonged observation of the effects of various types of trauma to the chest in individuals known previously to be well, will this question be settled with any degree of scientific exactness. From the observations now at our command it would be impossible to state conclusively that any type of bacterial disease of the chest is a direct result of trauma, unless infection is directly introduced into the chest cavity or lung, or a disease process previously existed in the lung.

Traumatic pleurisy is due to an irritation of the pleura produced by trauma, and has no connection with bacterial infection. Pleural effusion rarely develops and when it does the fluid is a transudate. We have never seen empyema develop as a direct result of trauma without penetration of the chest wall. One condition in which there may be some direct relation between injury and bacteria-produced disease is traumatic pneumonia. This is very rare but when pneumonia does follow injury it is usually of the lobar type presenting massive homogeneous consolidation of an entire lobe or greater portion of a lobe. There may be no roentgenographic evidence of disease for several days after the injury and then suddenly pneumonic consolidation develops. The roentgenographic picture is similar in all respects to ordinary lobar pneumonia as are also the clinical symptoms and course. At times the pneumonic consolidation develops near the site of injury; at times the injury is of some remote position of the body.

Defervescence is by crisis and prompt resolution results in complete restoration of the lung to normal. It is possible, of course, that this may be a coincidental pneumonic involvement having no relation to the trauma; in any event it is a very rare occurrence. In the roentgen-ray service of the St. Louis City Hospital in which a large

number of chest injuries have been seen in the past ten years, we have encountered fewer than half a dozen instances in which trauma could be established as a definite cause of pneumonic involvement.

A review of the literature discloses the fact that trauma has long been accepted as a possible cause of pneumonia. Litten³ in 1882 spoke of the condition as "Contusionspneumonie" and reported 14 cases among 320 males with pneumonia, an incidence of 4.4 per cent.

Stern⁹ reports 29 cases in a series of 1,027 cases of pneumonia as of traumatic origin, an incidence of 2.8 per cent. Most modern writers, however, hold that such figures are certainly too high and that if trauma is an etiological factor in the production of pneumonia it is extremely rare. Jürgensen and Aufrecht² held this view, and Pye-Smith and Beddard⁶ in 1909 stated that, "it is a debatable question how far injury may determine an attack of pneumonia." They do accept it as a possible cause, however. Jürgensen and Aufrecht obtained a history of trauma in not more than 0.13 per cent of their pneumonia patients. Norris and Farley⁵ found 58 cases in 6,790 collected cases, an incidence of 0.58 per cent. This figure is probably more nearly correct. Cole¹ failed to find a single instance in 770 cases of pneumonia.

When one considers the other conditions associated with trauma, such as pleurisy, massive atelectasis, contusion of the lung with interstitial hemorrhage, etc., which could easily be confused with pneumonic involvement, it is evident that this may account for the higher percentage reported by the older observers before the advent of the roentgen ray as a diagnostic agent. Likewise a few writers recognize a group of cases in which pneumonia results following severe trauma to some remote portion of the body on account of lowering of resisting power of the body or from nervous shock. In such a group are included pneumonia following operation; confinement; extraction of teeth; emboli occurring during the course of a septic infection from a

wound. Such a classification is obviously beyond the scope of this discussion.

The question of development of pulmonary tuberculosis after injury to the chest is also one of great importance, but one in which any accurate data are equally difficult to obtain. Inquiry from 500 patients suffering from pulmonary tuberculosis at Koch Hospital elicited a history of trauma in 32 instances. I am indebted to Dr. G. D. Kettlekamp and his staff of physicians for making this analysis for me.

Mrs. B. was in an automobile accident three years before her condition was diagnosed as tuberculous, at which time she fell against the steering wheel and injured her chest.

Miss K. was in automobile accident three and a half years before her condition was diagnosed as tuberculous. The car fell on her, crushing her chest and she had hemoptysis at that time.

Mrs. F. Automobile accident one year before diagnosis of tuberculosis was made; suffered injuries to head, and shaken up slightly.

Mrs. M. Automobile accident one year before her condition was diagnosed as tuberculous. Injured hand and shaken up a bit.

Mrs. H. Automobile accident, slight injury to chest and shoulder three years before diagnosis of tuberculosis was made.

Miss V. Four years prior to onset of illness patient was injured in automobile accident. Was injured twice; once had injury to lower left chest. Scar still remains; no ribs broken.

E. R. was thrown through windshield of automobile a short time before she became ill (about six months before onset of illness). She was unconscious at that time.

I. McC. was hit in back by service car two years prior to development of tuberculosis.

Miss B. Seven months before becoming ill patient was in automobile accident. Was in rumble seat of car when it went off the road. Sustained broken nose and injury to wrist. Was unconscious at time. About one month later was in another accident in which she was knocked unconscious but suffered no after ill effects at that time.

Mrs. S. At age of sixteen patient had severe blow on right upper chest. After that had several severe blows to chest and back (fist blows). This occurred about five years previous to her tuberculosis.

Mrs. M. was in automobile accident about eighteen years ago. Was unconscious and severely bruised.

Miss N. Six months prior to illness patient fell from bus and sustained laceration of leg. Not unconscious at time.

Miss P. Twelve years prior to illness with tuber-

culosis patient fell downstairs; legs were paralyzed. Had operation later and regained use of legs.

Mrs. C. broke ribs in 1914, and diagnosis of tuberculosis made in 1930.

Miss C. broke two ribs and punctured lung in 1924; diagnosed tuberculous in 1926.

Mrs. H. Automobile accident six weeks before she was diagnosed as tuberculous in 1927. Injury to abdomen.

Miss H. fell off horse in 1924, diagnosed tuberculous 1929.

Miss T. In automobile accident in 1925; injury to head. Diagnosed tuberculous in 1929.

Mrs. R. fell on ice in 1930. Diagnosed tuberculous in 1931.

Miss A. fell on chest when a child—1914. Diagnosed tuberculous in 1931.

Miss P. Colored. Broke leg in 1917; broke hip in 1916; diagnosed tuberculous in 1923.

Mr. C. Injured back three and a half years before diagnosed as tuberculous. Tuberculosis of spine as well. Diagnosed three years ago.

Mr. H. Fell on left side August, 1931. Left lung diagnosed as tuberculous February, 1932.

Mr. L. Struck by automobile, left side, 1929. Tuberculosis left lung diagnosed in 1930.

Mr. A. Log rolled over chest 1924. Tuberculosis left side diagnosed in September, 1930.

Mr. D. Left side hit by auto. Not severe, 1928; left lung diagnosed tuberculous 1930.

Mr. A. Broken right collar bone, twenty years ago. Bullet wound upper right chest, 1927. Tuberculosis right lung diagnosed in 1930.

Mr. S. Injured right side, 1930. Diagnosis of tuberculosis made one week later.

Mr. M. Crushed in elevator one year before onset of tuberculosis at which time received fractured spine and jaw.

Mr. C. Automobile accident three months before onset of tuberculosis. No special injury.

Mr. W. Fell on edge of table injuring lower chest six years before onset of tuberculosis. Said no ribs were broken at that time.

Mr. P. Painter, fell and injured shoulder five years before diagnosis of tuberculosis was made.

Total	White females	20	Colored females	8
32	White males	3	Colored male	1

It will be noted that the time elapsing between injury and the diagnosis of tuberculosis varied over a wide range—one week to eighteen years. In over half of the instances the chest itself was not shown to be directly involved in the accident—in some instances the trauma was confined to an extremity. In no instance was any patient shown to be free from the disease prior to injury.

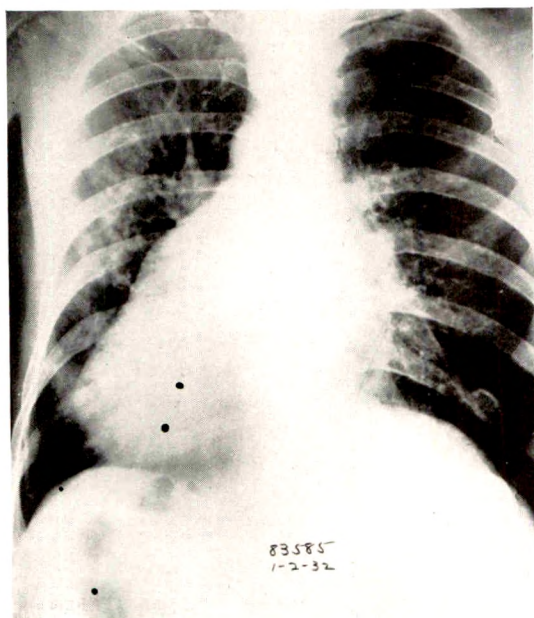


FIG. 3a. Anterior roentgen examination after injury. No fractures, no evidence of trauma on chest wall; nothing to indicate injury to the lung at this examination.

When the widespread occurrence of trauma of one sort or another and the prevalence of pulmonary tuberculosis are considered, it would not be justifiable to assume that the one was a determining factor in the production of the other. Where a definite tuberculous process is already present, an aggravation and extension of the condition from trauma could be more readily explained by a disturbance of the barrier of defense tissue about the lesion. Where tuberculosis subsequently results after trauma in an individual previously free from the disease, the supposition is that lowering of the patient's resisting power, either locally or generally, has given opportunity for the development of an ever present tuberculous infection.

Shipman⁸ holds this view and maintains that "pulmonary tuberculosis develops within a reasonable length of time in a previously healthy individual following trauma to the chest, sufficient to cause functional impairment. Fractured ribs or clavicle or severe contusions should be considered *prima facie* evidence of such an injury."

It would seem that before such a statement is accepted it should be more fully substantiated by numerous instances in which individuals previously demonstrated to be well, are shown to have developed tuberculosis within a reasonable length of time following trauma to the chest. Such cases should be supported by roentgen examination, laboratory examinations and all other available methods of diagnosis. Until this is accomplished the statement that trauma is a factor in the production of pulmonary tuberculosis will be challenged.

Surely in the face of these statistics we must admit that trauma certainly does not play more than a very minor part in the development of the disease. It is logical to suppose that trauma severe enough to cause actual injury to the lung might disturb the bodily defenses against a pre-existing tuberculous lesion by removing the fibrous tissue barrier and permitting an advancement of the disease, but that trauma alone is an etiological factor in its development is highly speculative.

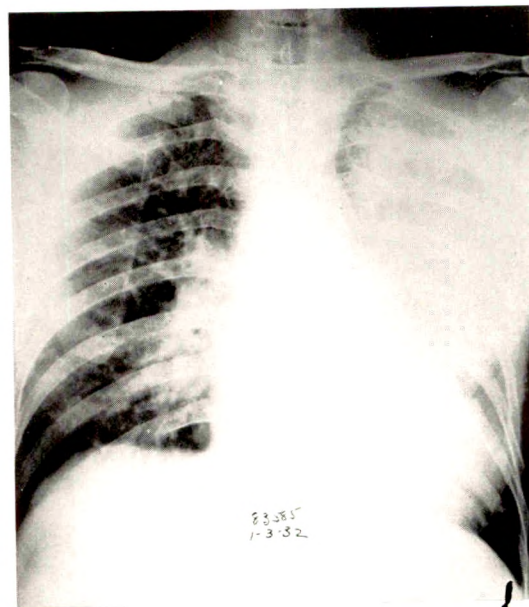


FIG. 3b. Posterior roentgen examination the following day showing dense consolidation of the left lung due to traumatic pneumonia. Course and resolution were uneventful. Pneumonic involvement was near site of injury.

In conclusion, it may be said that unless infection is actually carried into the pleural cavity by the effect of trauma, there is little likelihood of bacterial infection occurring. If infection does not develop, injuries to the chest heal completely with little danger of subsequent disability. If infection does occur from direct inoculation the roentgenographic appearance and prognosis are the same as that accompanying the same condition from any other cause. Likewise, since trauma has not been proved to be a direct etiological factor in the production of bacterial disease of the chest, any effect produced is probably produced indirectly

by lowering of the general resistance incident to trauma, or the activation of a pre-existing disease.

There seems to be a small percentage of cases in which slight trauma, insufficient in itself to operate through the mechanism of lowered bodily resistance, is followed by definite pneumonic consolidation. The exact mechanism by which this occurs is not known; the incidence is extremely low.

That tuberculosis ever develops in a previously healthy individual as a direct result of trauma in a similar manner seems very doubtful; if such instances do occur they must be extremely rare.

REFERENCES

1. COLE, R. I. Acute lobar pneumonia. In: Nelson's Loose Leaf Living Medicine, 1920, 1, 203.
2. JÜRGENSEN and AUFRECHT. Aufrecht, E. Die croupose Pneumonia. Nothnagel's Spec. Path. u. Therap., 1899, 14, 15.
3. LITTEN, M. Ueber die durch Contusion erzeugten Erkrankungen der Brustorgane, mit besonderer Berücksichtigung der Contusionspneumonie. *Ztschr. f. klin. Med.*, 1882, 5, 26-54.
4. LITTEN. Ueber Contusionspneumonie. *Berl. klin. Wchnschr.*, 1907, 44, 229.
5. NORRIS and FARLEY. Osler's Modern Medicine, Philadelphia, 1925, 1, 184.
6. PYE-SMITH, P. H., and BEDDARD, A. P. Lobar pneumonia. In: Allbutt and Rolleston's System of Medicine, Macmillan and Co., London, 1909, 5, 191.
7. SANTE, L. R. Injuries to the chest; radiological study. *J. Am. M. Ass.*, 1928, 91, 1603-1607.
8. SHIPMAN, S. J. Industrial tuberculosis. *J. Am. M. Ass.*, 1929, 93, 257-259.
9. STERN, R. Akute Lungenentzündungen. In: Ueber traumatische Entstehung innerer Krankheiten. II Auflage, Heft II, G. Fischer, Jena, 1913, p. 169.



TRAUMA AS AN ETIOLOGICAL FACTOR IN MALIGNANCY*

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THE subject of trauma as related to malignancy has been under intensive study since 1863 when Virchow¹⁰ presented his theory of chronic irritation in the causation of tumors. There are now more than three hundred contributions to the subject, comparatively few of which are in the English language. Although embryology and microbiology have added something to the present knowledge, the theory of chronic irritation has survived as the most widely accepted etiological factor in malignancy. In the present industrial age the question of trauma, especially the single severe trauma as contrasted with the repeated slight injury, has reached a place of first importance not only to the medical and legal professions but to the public at large because of the extensive holding of accident insurance and of the workman's compensation laws.

Among the contributions to this subject there are several masterly reviews: those of Graef¹² (1913) where one hundred and sixty references are cited, and of Knox¹⁷ (1929) where the whole subject is brought up to date, are especially commendable.

PRESENT STATUS OF THE PROBLEM

The present status of the problem may be readily expressed by referring to the summaries of previous contributions.

Thiem³⁷ (1909) declared that trauma is not the real cause of tumors, but that among the accessory causes it plays a very important rôle. Thiem's criteria for accepting a malignant tumor as traumatic in origin were:

1. Definite proof of accident.
2. Trauma must be of such severity as to produce injury.
3. Tumor need not be in exact site of injury as long as it occurs within the lines of stress produced by the trauma.
4. Interval between accident and appearance

of tumor must be reasonable—for sarcoma not less than eight days; for carcinoma not less than three to four weeks.

Berard³ (1910). It appears undeniable that, in predisposed subjects, notably by heredity and in conditions which escape our present method of analysis, trauma determines the appearance or favors the development of tumors. A single trauma, especially a severe contusion on tissues healthy in appearance, may be sufficient. This was observed particularly in sarcoma of soft parts, bones and in tumors of the brain. The time between the trauma and the appearance of the tumor may vary from several weeks to several years.

Phelps²⁹ (1910), considering only epithelial tumors. (1) "Cancer is primarily dependent upon a cause which is congenital, is hereditary in a certain proportion of cases and is as inexplicable as the force which determines in ovo the future sex and peculiarities of the individual. (2) Its development is favored by various indeterminate and non-essential conditions. (3) Its proximate cause is as yet entirely unknown and its future determination will depend upon the possible verification of a parasitic infection."

Coley⁵ (1911). (1) "Local trauma of any kind from chronic irritation to a single local contusion, is not infrequently the direct exciting cause of malignant tumors of all types." (2) "That a single local injury may cause a carcinoma as well as a sarcoma is no longer open to speculation. The cases that I have submitted fulfill all the conditions necessary to establish a definite causal relationship between a single trauma and the development of a cancer." (3) "While we must admit that trauma often plays an important causative role in the formation of malignant tumors, this relationship must be clearly and definitely established . . ."

Lubarsch²¹ (1912). "A causal relationship of a single trauma to the development of tumors is considered probable if (1) the trauma was of such a degree as to cause distinct and continuous changes at the place where the tumor subsequently develops; (2) the interval between

* From the Department of Pathology, Henry Ford Hospital, Detroit. Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

trauma and tumor is such as to account for the size and histological structure of the tumor. Acceleration or exacerbation of an already existing tumor is only probable if, (a) The trauma was of such a nature and localization as to cause distinct changes, particularly in the cell metabolism of the tumor. (b) The growth of the tumor was increased as compared with the empirical normal. (c) the histological examination revealed distinct traces of an injury, fresh hemorrhages, unusual necrosis and signs of extraordinary acceleration of growth."

Eunike⁶ (1919) reports 6 cases of bone sarcoma possibly due to a single trauma, but he believes that other factors enter their causation because of the rare occurrence. Points required for recognition of traumatic origin of sarcoma:

1. Trauma must be certain.
2. The intactness of part before trauma must be unquestionable.
3. The trauma must be of such a kind and degree as to injure the part.
4. The neoplasm must be found at the place of the injury.
5. The tumor must have developed after the trauma.
6. A temporal relation of the trauma to the onset of neoplasm should be recognized.
7. There should be continuous symptoms between the trauma and the evolution of the tumor (bridge symptoms).

Ophüls²⁶ (1921) states that "a single trauma not followed by complications is a rare cause of tumor. Complete data, including roentgen examination immediately after accident, are essential." Consensus of opinions on essential rules regarding trauma and malignancy are:

1. The occurrence of the trauma must be proved.
2. The trauma must have been severe enough to appear effective.
3. The growth must develop at a place likely to have been injured by the trauma.
4. It must be reasonably certain that the traumatized part was normal before the accident.
5. The time elapsing between the trauma and the appearance of the tumor must agree with our scientific experience in the rapidity of the development of the particular type of tumor under consideration. The time must not be too short, not less than

several weeks, nor too long, usually given as two years.

Sauerbruch²² (1925). General disorders play a much greater part than local disturbances in the genesis of tumors. Restates criteria as follows:

1. The injury must have been due to force, not to shock or fatigue.
2. The impact must have been sufficiently violent to produce marked changes forcing the patient to cease work at the time.
3. Carcinomata or sarcomata must develop at the site of injury.
4. The tumor must develop within a certain period (three weeks to three years in the case of sarcomata; one month to two years for carcinomata), though these intervals may be longer if so-called bridge symptoms can be demonstrated.

Ewing⁹ (1926). "There is not a single form of supposed traumatic cancer that does not arise frequently in the same form free from any suspicion of trauma. Conditions provided before trauma can be accepted as the cause of a tumor as established by rulings and statutes of most European countries and best American practice:"

1. The authenticity and sufficient severity of the trauma.
2. Previous integrity of the wounded part.
3. The identity of the injured area with that giving origin to the tumor.
4. The tumor must be of a type that could conceivably result from trauma.
5. There must be a proper time interval between the receipt of the injury and the appearance of the tumor.

Such data are difficult to obtain. Nevertheless without them one cannot assert that a tumor is of traumatic origin.

Knox¹⁷ (1929) quotes Lubarsch as giving the best summary as follows:

1. Blows and other injuries generally call attention to hitherto unsuspected tumors and proof of the existence of such unsuspected growth is given by the fact that neoplasms which have never given recognizable symptoms are constantly being discovered at autopsy.
2. Injuries are infinitely more frequent than neoplasms.
3. Many tumors have a long latent period.
4. Experimental evidence for the theory that

a single trauma can cause a tumor is lacking.

Knox's conclusions were:

1. Literature leads to the conclusion that a causative relation between a single trauma and a tumor has never been completely established.
2. Examples cited suggest possibility that a single trauma may induce a tumor, but proof is lacking.
3. A causative relationship can never be established until it is demonstrated by experimental methods that a single injury can regularly produce a tumor.
4. The award of compensation solely on the basis of the production of a tumor following a single trauma is therefore unjustified.
5. The award of compensation on the basis of trauma acting as a collateral or adjunct may be justifiable if proof of the injury is received and tumor is proven by the microscope.
6. Trauma which merely calls attention to a pre-existing tumor is not a valid basis for compensation.

It is quite apparent that the clinical evidence and the opinion of clinicians is more favorable to the theory of the traumatic origin of malignant tumors than the experimental evidence and the opinion of research workers or the pathological evidence and the opinion of pathologists. The difference of opinion lies not in the criteria alone but largely in the strict adherence to objective data to make up the criteria. The patient's history uncorroborated is insufficient.

Further consideration of the problem necessarily is limited to recent data and may be divided into experimental and clinical.

EXPERIMENTAL

As early as 1863 Virchow³⁹ admitted that trauma might produce a malignant neoplasm, but qualified his admission by demanding a predisposition in the patient and a soil made favorable by pre-existing pathology. Heredity may now be spoken of as a predisposing factor in malignancy from the

experimental viewpoint at least, although not readily demonstrated in man. Slye³⁵ has recently presented data on neoplasms in mice at the site of gross trauma, including detailed protocols. The traumata recorded are of the major variety including bites, fractures and lacerated wounds from cage doors, etc. Of the 14,000 autopsies recorded, 1,301, or 9.2 per cent, showed neoplasms. Fifty-one of the 1,301, or 3.8 per cent, arose in the site of recorded traumata, thus making an incidence of malignancy of 0.36 per cent due to trauma. There were 34 malignant tumors—30 sarcomas, or 88 per cent, and 4 carcinomas, or 12 per cent. The high percentage of sarcomas following trauma is perhaps significant as one is impressed from the protocols given by the fact that most of the stock was carcinomatous rather than sarcomatous. It is emphasized that, in the non-cancerous strains of mice bred in the same laboratory, identical traumas have occurred without a single tumor arising. Slye's conclusion that the described hereditary predispositions and external gross traumas were the interrelated causes of the occurrence of neoplasms seems conservative. The data refute to some extent the often quoted point of Lubarsch that the experimental evidence for the theory that a single trauma can cause a tumor is lacking, but hardly answers the challenge of Knox that, "The causative relationship can never be established until it is demonstrated by experimental methods that a single injury can regularly produce tumor," because the incidence of trauma is not recorded. However, this is the first extensive experimental contribution which applies directly to the problem and is a long step in the proper direction.

Endocrine abnormalities and imbalance have again been brought forward as predisposing factors in malignant disease, this time with more tangible experimental basis. In 1930 Zondek⁴¹ showed that out of 118 cases of malignant tumors 15 per cent were excreting in the urine sufficient anterior pituitary hormone to produce a positive Aschheim-Zondek reaction in immature fe-

male mice. More recently it has been shown that teratoid tumors of the testicle give a high percentage of positive Aschheim-Zondek tests. Further, the removal of the anterior lobe of the pituitary has been shown to arrest or at least retard the growth of malignant tumors in the experimental animal. In our own laboratories anterior lobe extracts, supplied through the courtesy of Parke-Davis and Company, have increased the number of takes in transplanted carcinoma as well as the rate of growth of these transplanted tumors in the rat.

The disturbance of calcium and phosphorus metabolism, associated in many instances with hyperfunction of the parathyroid glands and resulting in osteitis fibrosa cystica and Paget's disease, are frequently associated clinically with tumor formation. As Jaffe¹⁵ has shown, osteitis fibrosa cystica is readily produced by injections of parathormone. Paik²⁸ has now carried the work a step further by daily injecting parathormone into rats with transplanted tumors, increasing the growth three times over that of the controls. Removal of the parathyroids in these animals, on the other hand, retarded the growth of the transplanted tumors.

These two groups of experimental observations on glands of internal secretion and heredity in relation to tumor growth make the conception of predisposition to malignancy a tangible thing capable of much further investigation. It is possible, of course, that hereditary predisposition and endocrine predisposition are one and the same.

CLINICAL

Clinical investigation of the relation of trauma and malignancy is at the present time most unsatisfactory largely because it is impossible to evaluate the history of the patient, even when the history is obtained by an experienced investigator and leading questions are carefully avoided. Examination immediately after the accident, including roentgenograms, is required to satisfy the criteria outlined above, particularly re-

garding the extent, nature and location of the injury and exclusion of pre-existing malignancy. Even when the examination is done it is difficult to determine the integrity of the part before the injury except in case of fracture. The impression is gained, in reviewing the clinical articles, that the relationship is established by mere multiplication of cases without strict observance of all the criteria set up by the author himself, to say nothing about satisfying the accepted comprehensive criteria. Similar criticism must be made of the large compilation of cases where complete history and data are rarely if ever available. The most reliable reports should come from an experienced investigator familiar with the subject, or a small group working under the direct supervision of such an individual. The records of the large hospital or clinic, where these are obtained by an ever-changing group of young physicians, are open to question. For example, in a group of 150 breast cases in our own clinic there is a recorded traumatic factor of 9.3 per cent, but a critical review of these histories does not reveal a single case which satisfies the comprehensive criteria necessary to establish this factor.

It is logical to consider first the tumors of the skin and mucous membrane, since these areas are traumatized more often than other parts of the body.

1. Carcinoma of the skin. Seventy-five cases of basal cell carcinoma are reported by Paul²⁸ in which there was a definite history of trauma in 21, or 28 per cent. The injuries mentioned were mosquito bite, cut while shaving, scratch from pin, burn from hot grease while cooking, burn from hot tar while repairing roads, etc. Obviously with such minor injuries the integrity of the part before the injury could not be established, and few, if any, were observed until the tumor was fully developed. A more acceptable case is that of F. C., male, aged forty-seven, seen in our cancer clinic, whose face was free of skin lesions at time of employment but was struck on the chin by a piece of hot steel. He was immediately

treated in the accident department. The wound was clean and there was no evidence of tumor. The wound did not heal, but left a shallow ulcer, and one and a half years later the present condition, consisting of a small fissure with slightly elevated rolled edges, developed. Removal and sections confirmed the clinical diagnosis of basal cell carcinoma.

Squamous cell carcinoma of the skin and mucous membranes resulting from trauma is frequently reported, but the great majority of these arise in pre-existing lesions such as old scars, chronic ulcers, areas of keratosis or leucoplakia. Areas of marked keratosis in the sunburned, weather-beaten face of the farmer are frequently the site of squamous cell carcinoma. Trauma merely accelerates growth or more often calls attention to the lesion by removing the scab. A similar situation is connected with leucoplakia of the mouth and tongue. The best examples of squamous cell carcinoma in relation to trauma are the recent ones recorded by Schad²² resulting from war wounds. The first is a male, aged twenty-six, whose left cheek was penetrated by a bullet in November, 1914. Healing was satisfactory, but in March, 1915, scar became thickened and in June, 1915, while on active duty at the front, was shown to have a squamous cell carcinoma involving all parts of the former wound. The second was a male, aged thirty-six, whose left temple was grazed by a bullet and injured in February, 1915. Wound healed in three weeks allowing return to front. In July the scar became painful and in August he could no longer wear his helmet because of ulceration and pain.

2. Melanoma. The development of malignancy in the pigmented mole (nevus pigmentosus) represents one of our best examples of ready transition from a benign congenital lesion of long standing to one of high malignancy. This transition often takes place without a known aggravating factor, but chronic irritation, repeated minor traumata or a single major trauma are recognized as precipitating causes. We are prob-

ably never justified in attributing malignancy in these nevi to a single trauma because of their known tendency to spontaneous change, and a careful microscopic examination of the entire lesion before injury would be required to rule out cellular malignancy. However, aggravation and acceleration must be admitted in many of these cases, and an example cited by Evans and Leucutia⁷ serves well to illustrate: G. W., white male, aged twenty-six, had had a pigmented mole on the inner aspect of the upper third of the left leg since birth. August 21, 1928, this was injured by flying metal causing bleeding and subsequent infection. Ulceration persisted and the whole lesion was excised five weeks after injury. No suggestion of malignancy was found. Four months after injury there was recurrence in the wound, and a diagnosis of melanosarcoma was made. Recurrences and metastases from this group are often recorded, sometimes following partial surgical removal, electrocoagulation and deep roentgen treatment. Several years ago Warthin and Case, in a paper still unpublished, presented the view that the important factor in these unfortunate results seemed to be the enclosure of some of the scattered chromatophores in scar tissue. Their studies suggest trauma as a possible indirect factor activating the cells through scarring. Review of 58 cases, obtained from the personal files of Dr. Evans and Dr. Nolting, showed 5, or 9.8 per cent, activated by a single trauma; 4, or 7.8 per cent, activated by repeated traumas or chronic irritation; 7, or 13.7 per cent, activated by operative removal. According to the work of Masson²⁴ melanomas are tumors of nerve endings, and the specialized nerve terminations of the Meissner corpuscles have been confirmed by other observers. The acceptance of this view would place the derivation of this much disputed group with the neurogenic tumors. Stewart and Copeland²⁶ discuss the whole subject under the title of neurogenic sarcoma.

The neurogenic tumors, according to Stewart and Copeland, may now include

most of the so-called fibromata and fibrosarcomata of the skin and soft parts. Of the 129 cases of neurogenic sarcomata reported by Stewart and Copeland, only 3 claimed trauma as an etiological factor, and in none of these is the evidence convincing. However, the regularity with which a long stationary tumor recurred and grew rapidly after the first or second surgical removal points to the definite possibility of activation by trauma in this group.

3. Carcinoma of the breast. Traumatic history in breast carcinoma is obtained in almost any patient if leading questions are asked, and, avoiding this error, trauma is frequently given as a cause by the patient. Trauma has been recorded as an etiological factor in from 2.6 per cent by Hildebrand¹⁴ to 44.6 per cent by McWilliams.²⁸ The statistics on trauma antecedent to breast carcinoma from various countries are given by Lane-Dayton¹⁹ as follows:

Country	Author	Total Cases	Cases of Trauma	Per Cent
England	5	742	129	17.4
America	6	1,133	190	16.8
Germany	15	3,003	244	8.1
Austria	2	858	88	10.2
Switzerland	4	495	60	12.1
Czechoslovakia	2	583	50	10.3
Norway	2	176	15	8.5
Denmark	1	210	14	6.6
Italy	1	204	11	5.4
Hungary	1	108	11	10.2
		7,510	822	10.9

Luff²² in 1932 found a history of injury in only 8 per cent of 1,651 cases reviewed and declared the history of dubious nature in many of these. On the other hand, there was a family history of cancer in 23.1 per cent.

The high incidence of chronic cystic mastitis in the breast alone would rule out the possibility of most cases satisfying the criteria necessary for admission of traumatic origin. A critical analysis would probably fail to confirm the traumatic origin of a single case as pointed out in our series.

4. Tumors of body cavities and internal organs. There are no tumors of the pleura

with reasonably good history for traumatic etiology. Only two carcinomas of the lung recorded in the literature are worthy of consideration. One of these is the familiar case of Lepine²⁰ which died five weeks after the accident, too soon for the development and fatal infiltration of carcinoma. The other is that of Wells and Cannon.⁴⁰ Male, aged fifty, knocked down by an automobile fracturing 3, 4 and 5 ribs. Fractures were confirmed by roentgen examination, but nothing suggestive of lung tumor was found. Lung injury was indicated by hemoptysis and subcutaneous emphysema over the entire body. Eleven months later the patient developed cough and other symptoms suggestive of tuberculosis. Roentgen examination at this time showed carcinoma in site of fracture. Autopsy showed a mesothelioma. This case satisfies all criteria closely.

Tumors of the intestinal tract are generally conceded to be activated by chronic infection and irritation, as are those which arise in the stomach on the basis of peptic ulcer, those in the gallbladder almost invariably associated with gallstones, and those in sigmoid and rectum associated with polypi. It is difficult to conceive of a trauma of such type and severity as to injure the lining mucosa without causing perforation directly or indirectly.

Tumors of the uterus, tubes and ovaries, especially of the cervix, are often ascribed to trauma but the type of trauma associated with tears during childbirth. This is confirmed to some extent by the fact that from 80 to 90 per cent of cervical carcinoma occur in women who have borne children.

Tumors of the urinary system, particularly those of the kidney, loosely grouped under the term "hypernephroma," are important because trauma is frequently claimed as a cause of the primary tumor and the localization of metastases, particularly in bone with or without pathological fracture. So-called hypernephromata arise from adenomata or congenital rests (Grawitz's adenoma). Hence the most that could be claimed would be activation of a pre-existing tumor. Rückart²¹ has reviewed 117

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cases from the literature with history of trauma in 9. Of the 9 only 4, or 3.4 per cent, are truly suggestive of traumatic origin. Rückart's own case fell from a roof sustaining a blow in the mesogastrium. This was followed immediately by blood and pus in the urine, although there had been no previous kidney difficulty. Dr. Nolting has reviewed 40 cases of hypernephroma in Harper Hospital, Detroit, and finds only one case with a history of trauma. In this case there were no immediate symptoms of kidney damage, and the tumor appeared three years later. It would be almost impossible to determine the integrity of the kidney at the time of the accident, and if adenomas or Grawitz's tumors were present, only careful microscopic examination would prove that malignancy was not present before the trauma. The possibility of the activation of a congenital rest or adenoma is the only thing to be considered, and then only when there are immediate signs of kidney injury such as bleeding, anuria, etc.

Tumors of the testicles, like tumors of the breast, have frequently been designated as traumatic in origin probably because the testicles are subject to trauma and any injury in this region is very painful, making a lasting impression on the recipient. As Ewing⁸ points out, it is best to consider this group of tumors from the standpoint of their teratomatous origin, and they can be separated from any serious claim of traumatic origin on this score alone. The congenital basis, coupled with the recent demonstration of hyperactivity of the anterior lobe of the pituitary in this group, makes it seem beside the point to suggest more than the activation of a pre-existing lesion with endocrine background. Unconvincing cases, such as that of Kopas,¹⁸ are recorded in the literature. Male, aged fifty, a brewer, was shot in thigh and testicle. Bits of lead remained in the testicle but the wound healed readily. Four years later a rapidly fatal carcinoma of mixed type appeared.

Three cases of lymphosarcoma are re-

corded as caused by trauma, those of Pistocchi,²⁰ Fiddes and Phillips,¹¹ and Cenini.⁴ Of these, the case of Fiddes and Phillips is of most interest. Male, aged fifty, was struck on back of neck with a leather belt from a machine. Three days later a lump appeared at the site of injury, and in two months a whole chain of glands on this side of the neck was enlarged and indurated. Autopsy revealed extensive involvement of all the abdominal glands, and it was concluded that this was the primary site of the sarcoma. The medical referee, however, awarded compensation, because of:

1. Definite evidence of injury, namely, blow at the back of the neck arising in the course of his work.
2. Appearance of a swelling close to the site of injury shortly afterward.
3. Possibility of such an injury (a) causing activity in a previously existing sarcoma; (b) precipitating such a development.

In view of the autopsy findings neither of these possibilities was correct, but a third should be considered, that is, the injury may have influenced localization in the neck from the advanced abdominal tumor. This possibility is well illustrated in the experimental work of Jones and Rous¹⁶ where it was shown that mouse carcinoma could be influenced to localize by a local mechanical irritant. They conclude that secondary localization of tumors at points of injury may be attributed with good reason to the presence at such points of an active connective tissue capable of elaborating a stroma rapidly and abundantly. Granting that injury had to do with localization in the neck, it was not a cause of disability or death, and hence the compensation was unjustified. By the same token, if injury could be shown to influence localization to vital spots causing disability or death, trauma might be more often a just cause for compensation in tumor cases.

Brain tumors are frequently associated with injury by the patient. Adler¹ in 1899

collected 1,086 cases in which 96, or 8.8 per cent, gave a history of trauma. With the brain, integrity of the part before injury and actual destruction of tissue are criteria that are hard to satisfy. The most plausible cases are those reported by Neubürger²⁵ of brain gliomata following gunshot wounds. Three brains with tumors following gunshot wounds are preserved in the museum of the German Research Institute for Psychiatry. Neubürger accepts 2 cases as directly due to the injury, but grants that a certain disposition on the part of the patient to tumor must be considered.

Bone sarcoma is more frequently referred to trauma than either sarcoma of soft parts or carcinoma. Like trauma to the testicle, trauma to bone is usually quite painful and in addition there is usually sufficient reaction to produce a palpable tumor which remains for some time. The pain and tumor focus the patient's attention on the injury and, if sarcoma ever develops in that region, the injury is regarded as the cause. The use of the roentgen ray to check a possible fracture at the time of the injury gives a permanent record which assures the integrity of the part so that in a properly observed case there should never be a question of pre-existing tumor. Traumatic periostitis and callous formation are such active reparative processes that, even with the microscope, they are difficult to distinguish from sarcoma. Hence, as far as the local tissues are concerned, there is little margin of safety. Sarcoma is often reported as developing in the callus of a fracture as in the case of Haberman:¹³ Male, aged fifty-four, whose fracture at the lower end of the humerus healed satisfactorily in six weeks but developed a large osteochondrosarcoma in the following nine months. Troell,³⁸ in a critical review of 59 bone sarcomata, concluded that 9, or 15 per cent were undoubtedly due to trauma and that the subperiosteal hemorrhages with the subsequent organization were particularly favorable for the development of sarcoma. Ewing¹⁰ feels that there is convincing evidence that benign

giant cell tumors result from hemorrhages, often traumatic and usually into areas of osteitis fibrosa cystica. The etiological factor in osteitis fibrosa cystica is an excess of parathormone either injected experimentally or produced by parathyroid tumors. Development of osteogenic sarcoma in these giant cell tumors has been seen frequently. Ballin and Morse² place Paget's disease in the same group with osteitis fibrosa cystica and believe that both are due to parathyroidism. If we accept this point of view, all cases of parathyroidism, including Paget's disease, would constitute a predisposition to sarcoma on a hormonal basis, and trauma in such cases could be considered as an incidental or at most an activating factor. Unpublished statistics, furnished by Bloodgood and Geschickter, of cases recorded in the Surgical Pathological Laboratory of Johns Hopkins Hospital, give 179 bone cysts with a history of trauma in 55, or 31 per cent, and 206 giant cell tumors with a history of trauma in 74, or 31 per cent. These figures tend to confirm the fact that trauma simply calls attention to the lesion rather than produces it.

From a statistical point of view, bone sarcoma is referred to trauma in from 10 to 50 per cent of cases. Sebestyén³⁴ reviewed 4,068 sarcomas, reported between 1880 and 1920, of which 612, or 15 per cent, were associated with trauma. Of 429 bone sarcomas 231, or 44 per cent, were recorded as being referred to a single trauma. As pointed out by Codman, bone sarcoma in persons over fifty very commonly arises in a bone the seat of Paget's disease. The relation to fracture and also to Paget's disease is well illustrated in a recent case in our orthopedic clinic. Mrs. B., aged fifty-six, had an injury to the right leg twenty years ago. There were no further symptoms for ten years when she noticed bowing of this leg. In March, 1932, the leg became swollen and tender during an attack of influenza. Examination revealed Paget's disease of the right femur with osteogenic sarcoma in the lower third. Amputation was done

with good recovery. In July, while sitting on a couch she started to rise quickly without thinking of her amputated leg, and fell injuring her right forearm. Roentgen examination revealed greenstick fracture of the radius, and Paget's disease. Pain continued and on August 24, 1932, roentgenograms revealed early changes suggesting sarcoma. At the present time there is a large bony growth with the typical ray appearance confirming previous diagnosis. This case fulfills all the criteria regarding the relation of trauma to malignancy including individual susceptibility as proved by the first tumor in the humerus and the predisposition of the part in the way of Paget's disease. In a review of 56 sarcomas of bone in the personal files of Dr. Wm. A. Evans, Dr. Nolting found 17, or 30.3 per cent, with history of trauma, but only the patient's statement was available to establish the integrity of the part at the time of injury.

Unpublished statistics in 910 bone sarcomas, studied at the Surgical Pathological Laboratory of Johns Hopkins Hospital and kindly made available by Dr. Bloodgood and Dr. Geschickter, give 215, or 23 per cent, associated with trauma. No attempt was made to select the cases, if any, that would satisfy all the criteria. Although there is a better opportunity in bone sarcoma to check up on the injury and the integrity of the bone at the time of injury by means of the roentgen ray than there is on other group of malignancy, the cases that satisfy all criteria are rare. Probably our

case of sarcoma in Paget's disease is as satisfactory as any recorded. Fortunately the patient alone was to blame for the injury.

SUMMARY

1. There are accumulating experimental and clinical data indicating some types of predisposition to malignancy, especially in the fields of heredity and endocrinology.
2. Slye has produced experimental evidence that trauma may influence malignancy where hereditary predisposition is present.
3. Neurogenic tumors, including melanomas, hypernephromata and teratoid testicular tumors, all have a congenital basis so that trauma cannot be considered a true etiological factor, although it may be an activating one.
4. Either courts must recognize predisposition to cancer as ruling out traumatic etiology or employers will refuse to hire employees with such predisposition.
5. The criteria of Eunike and of Ewing with the addition, "There is no demonstrated predisposition to cancer," must be strictly adhered to by both the medical profession and the courts.
6. Few cases are recorded which satisfy the criteria necessary to demonstrate the relation of trauma to malignancy. It behooves the employer, the patient and the physician to cooperate in obtaining accurate objective data at the time of the injury as well as during the subsequent period.*

* For discussion see page 49.

REFERENCES

1. ADLER. *Arch. f. Unfallheilk.*, 1899, 2, 189.
2. BALLIN, M., and MORSE, E. F. Parathyroidism and parathyroidectomy. *Ann. Surg.*, 1931, 94, 592-609.
3. BERARD, L. Conference internationale pour l'étude du cancer, Paris, 1910.
4. CENINI, E. Linfosarcoma e trauma. *Gazz. d. osp.*, 1930, 51, 459-466.
5. COLEY, W. B. Injury as a causative factor in cancer. *Ann. Surg.*, 1911, 53, 449; 615.
6. EUNIKE, K. W. Zur Entstehung des traumatischen Sarkoma. *Deutsche Ztschr. f. Chir.*, 1919, 151, 262-271.
7. EVANS, W. A., and LEUCUTIA, T. The Treatment of melanotic tumors of the skin: pigmented moles and malignant melanomas. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1931, 26, 236-259.
8. EWING, J. Neoplastic Diseases. W. B. Saunders, Philadelphia, 1922.
9. EWING, J. Relation of trauma to malignant tumors. *Am. J. Surg.*, 1926, 40, 30-36.
10. EWING, J. Causation, Diagnosis and Treatment of Cancer. Williams and Wilkins Co., Baltimore, 1931.
11. FIDDES and PHILLIPS. *M. J. Australia*, 2, 637.

12. GRAEF, W. Trauma and tumor. *Centralbl. f. d. Grenzgeb. d. Med. u. Chir.*, 1913, 17, 603-637.
13. HABERAN. *Arch. f. klin. Chir.*, 1910, 17, 69.
14. HILDEBRAND. Beitrag zur Statistik des Mammacarcinoms der Frau. *Deutsche Ztschr. f. Chir.*, 1886-1887, 25, 337-369.
15. JAFFE, H. L., BODANSKY, A., and BLAIR, J. E. Fibrous osteodystrophy (osteitis fibrosa) in experimental hyperparathyroidism of guinea-pigs. *Arch. Path.*, 1931, 11, 207-228.
16. JONES, F. S., and ROUS, P. On the cause of the localization of secondary tumors at points of injury. *J. Exper. M.*, 1914, 20, 404-412.
17. KNOX, LEILA C. Trauma and tumors. *Arch. Path.*, 1929, 7, 274.
18. KOPAS, E. Sarkom nach Trauma. *Monatschr. f. Unfallh.*, 1929, 36, 541-546.
19. LANE-DAYTON, JANET E. Reports on Public Health and Medical Subjects No. 28, London, 1924.
20. LEPINE. *Lyon-méd.*, 1903, 100, 18.
21. LUBARSCH. Die Bedeutung des Traumas für Entstehung und Wachstum krankhafter Gewächse. *Med. Klin.*, 1912, 8, 1651-1654.
22. LUFF, A. P. Collective investigation into incidence of cancer of the breast and its history after treatment. *Brit. M. J.*, 1932, 1, 987-903.
23. McWILLIAMS, C. A. Statistics of one hundred cases of cancer of the breast and results of operation. *Med. News*, 1900, 76, 644-648.
24. MASSON, P. Pigmented nevi; nerve tumors. *Ann. d'anat. path.*, 1926, 3, 417-453; 657-696.
25. NEUBÜRGER, K. Gliomas after gunshot wounds of the brain. *München. med. Wchnschr.*, 1925, 72, 508-510.
26. OPHÜLS, W. Relationship between trauma and malignant disease from an industrial viewpoint. *Calif. State J. M.*, 1921, 19, 54-56.
27. PAIK, T. S. On relationship between parathyroid hormone and growth of rat carcinoma. *Am. J. Cancer*, 1931, 15, 2756-2764.
28. PAUL, NORMAN. M. *J. Australia*, 2, 826.
29. PHELPS, C. The relation of trauma to cancer formation. *Ann. Surg.*, 1910, 51, 609-635.
30. PISTOCCHI, G. Cancer and trauma. *Policlinico*, 1923, 30 (sez. chir.), 83-112.
31. RÜCKART. Hypernephroma after accident. *Deutsche med. Wchnschr.*, 1923, 49, 384-385.
32. SAUERBRUCH, F. Geschwülst und Trauma. *Deutsche Ztschr. f. Chir.*, 1926, 199, 1-10.
33. SCHAD, M. Zur Frage der Bedeutung des einmaligen Traumas für die Entstehung des Krebses und den Verlauf des Leidens. *Ztschr. f. Krebsforsch.*, 1930, 32, 43-52.
34. SEBESTYÉN, J. Traumatic sarcoma of bone. *Arch. f. klin. Chir.*, 1925, 136, 716-738.
35. SLYE, M. Interrelation between hereditary predisposition and external factors in causation of cancer; neoplasms in mice at site of gross traumas. *Ann. Surg.*, 1931, 93, 40-49.
36. STEWART, F. W., and COPELAND, M. M. Neurogenic sarcoma. *Am. J. Cancer*, 1931, 15, 1235-1320.
37. THIEM, CARL. Handbuch der Unfallerkankungen auf Grund ärztlicher Erfahrungen. Second edition. F. Enke, Stuttgart, 1909, p. 589.
38. TROELL, A. Trauma und Knochensarkom. *Virchow's Arch. f. path. Anat.*, 1932, 283, 550-574.
39. VIRCHOW, R. Die krankhaften Geschwülste. A. Hirschwald, Berlin, 1863, p. 35.
40. WELLS, H. G., and CANNON, P. R. Primary carcinoma of lung following trauma. *Arch. Path.*, 1930, 9, 869-873.
41. ZONDEK, B. Ueber die Hormone des Hypophysenborderlappens; Follikelreifungshormon (Prolan A) und Tumoren. *Klin. Wchnschr.*, 1930, 9, 679-682.



THE RELATION OF TRAUMA TO ARTHRITIS*

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THE relation of injury to disability of workmen has assumed an increasing importance during the past few decades. This is due partly to the speeding up of industrial work and the installation of labor saving machinery. The medicolegal aspect, however, has been brought to the forefront by the gradual tightening of the workmen's compensation laws. At the present time, nearly every disability is under suspicion of having been caused either by an accident or by the nature of the man's work. The physician has been obtruded into this breach because of his special knowledge, not only in regard to the amount of disability present, but also as to what other anatomical and physiological processes might be factors in producing the disability in question.

The relation of trauma to arthritis is an ever present question due to the widespread occurrence of arthritis and to the fact that the exact etiology in any given case of arthritis is often very obscure. Another disturbing factor is the fact that roentgen signs of arthritis may be present for long periods of time without clinical signs or symptoms. The words "traumatic arthritis" have come to mean those chronic changes in and around a joint after injury that resemble arthritis, such as synovial thickening, necrosis of the cartilage with narrowing of the joint space, and bone proliferation. This arthritis simulates the type which goes by the names hypertrophic, degenerative, osteoarthritis, and arthritis deformans, depending upon the nationality of the writer. We prefer the name hypertrophic arthritis and will so refer to it in this communication. This is not to imply that the atrophic type of arthritis cannot be produced by some type of trauma, but it is not the usual sequence of events.

Consideration of the general subject together with the various theories as to the anatomical joint changes which are followed by arthritis leads to certain questions: (1) Can injury produce arthritis? (2) What type or severity of injury is necessary to produce these joint changes? (3) What is the time interval between the injury and the occurrence of joint changes? (4) Can the changes which occur after injury be distinguished from those which characterize the usual types of arthritis? (5) What effect, both temporary and permanent, does injury produce on an already existing arthritis?

These questions are of great importance in medicolegal work where one is called upon for expert testimony. They are of particular importance to the roentgenologist for it is by his examination that direct evidence is obtained as to the structural changes which may result in loss of function. It is incumbent upon the roentgenologist, who desires recognition as a qualified expert witness, to make a thorough study of this subject. He should be well acquainted not only with bone and joint changes resulting from injury but with those changes resulting from disorganization of the mechanics of the joint and those congenital anatomical anomalies which are so frequently present.

PATHOGENESIS OF HYPERTROPHIC ARTHRITIS

Various theories have been evolved from time to time to account for the underlying changes in the production of hypertrophic arthritis and much experimental work has been done in attempts to prove or disprove these theories. The principal theories relate in general to vascular changes, cartilaginous changes, and bony changes.

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Most of the experiments were conducted with a view of producing changes in one or more of these structures.

The theory of ischemia as the etiological factor in hypertrophic arthritis was propounded by Wollenberg¹⁹ who believed the changes to be secondary to a local arteriosclerosis. In order to prove his theory, he ligated the blood supply of the patella and thereby obtained an overgrowth of it which he believed was due to the ischemia so produced. Axhausen and Pels⁴ repeated the work and ascribed the changes to cartilaginous necrosis and not to ischemia. Recently, Goldhaft, Wright, and Pemberton¹⁵ repeated the experiments of Wollenberg and obtained considerable overgrowth of the patella in every case after nine or ten months. They state that their experiments, taken in conjunction with those of Wollenberg, admit of no doubt that at least some of the characteristic changes of arthritis can be produced by interference with the blood supply.

Leriche²⁴ believes the osteocartilaginous lesions to be of hyperemic origin and states that the hyperemia may be traumatic in origin. His description of the mechanism of production of these lesions is as follows.

"Trauma of an articular region produces at this level a hyperaemic reaction. If this persists for longer than ten days, it results in synovial, osseous, and cartilaginous changes. In the synovia (if it is one of great size like the knee) it gives a real subacute aseptic synovitis with marked exudation of fluid, thus creating a hydrarthrosis. In the bone it occasions active rarefaction, lacunar osteoporosis, which is evident on x-ray plates. When rarefaction reaches the subchondral part, the cartilage becomes detached, shows nutritive troubles, and is even destroyed in some parts. Then we have what is called traumatic arthritis."

Goldhaft, Wright, and Pemberton state that Leriche's principle that stasis of the circulation favors ossification is in striking agreement with the results of their work quoted above.

Cartilaginous changes have been the subject of much experimental work to deter-

mine the rôle they play in the development of hypertrophic arthritis. Axhausen,² after doing considerable work on this subject, came to the conclusion that cartilage necrosis with the presence of devitalized cartilage in the joint was the cause of the arthritis. Key¹⁹ studied the joint changes after the aseptic removal of pieces of cartilage from the lower end of the femur. In some cases the operative defect healed with a smooth, shallow defect, and in others remained deep. Hyperplastic changes were usually found around the lower end of the femur, but were not necessarily in proximity to the operative defect. Changes were found also around the tibia and patella. These changes were not dependent on the presence of dead cartilage as no changes were noted in the good knee when pieces of cartilage were placed there. The author could not explain why, when two joints are subjected to the same trauma, one will heal normally and the other will show evidence of hypertrophic arthritis.

Kroh,²⁵ in order to test the mechanical function theory, resected one condyle of the femur in rabbits and produced changes similar to arthritis in the joint. This is hardly a fair test, however, as he produced surgical injury of both cartilage and bone as well as faulty mechanics of the joint. Key¹⁸ tested the mechanical theory by producing knock-knee in young rabbits by forcible bending of the knees outward at weekly intervals. In seven rabbits which grew to adult life, there was definite chronic hypertrophic arthritis. It was believed, however, that the arthritis was produced by disorganization of the joint, or cartilage and bone injury, and not to faulty mechanics in weight bearing.

Numerous investigators, stimulated by Axhausen's work, have attempted to produce arthritis by the introduction of various chemicals into the joint space, but it is impossible in these cases to state definitely which anatomical injury produced the arthritis, due to the various tissues affected. However, Burckhardt,⁷ in addition to the chemical injury, immobilized

the joints in some of his animals. He obtained the usual arthritic changes in the animals which used the joints, but in those with immobilization, the cartilage remained for a longer interval and was gradually replaced by connective tissue and tended to produce a picture similar to atrophic arthritis. Villi were found in the used joints and pannus in the immobilized joints. He believes that hypertrophic arthritis is a regeneration phenomenon due to cartilaginous injury.

Other investigators have employed various experimental means to accomplish the same result. Fisher¹³ applied radium directly to the joint surfaces. Wehner²⁸ resected the patella, and Klinge²¹ injected egg white into the knee joint. These, however, accomplish the same result in a different manner, except that Klinge's experiments lead us to believe that he depended upon an anaphylactic reaction as other joints in the body were similarly affected.

From the review given above, it is evident that many theories have been advanced to account for the origin of hypertrophic arthritis, and that most of them relate to some form of trauma, either physical or toxic, or both. Much of the experimental work reported could produce injury to a number of the joint structures and should not be cited to prove a theory that accounts for the production of hypertrophic arthritis by injury to a specific joint structure.

CLINICAL OBSERVATIONS

The question as to whether injury can produce arthritis is indeed an important one, and various facts and opinions must be considered in arriving at an answer.

Fisher¹⁴ states that, "osteo-arthritis does not constitute a disease *sui generis*, but rather the series of physiological or pathological changes that occur in a joint when it is subjected to prolonged or oft-repeated injury, either mechanical or toxic, but of a moderate degree of intensity." He also states that in traumatic or localized osteo-arthritis, trauma appears to form the main

or even the sole etiological factor, and does not constitute merely a predisposing etiological element. Where trauma is the direct etiological factor, he believes it to be due to frequently repeated traumata, while in those cases where trauma is the predisposing cause, it is more likely to be caused by a solitary contusion.

Holm¹⁷ follows Leriche's theory somewhat. He states that in a simple trauma of the knee there is first a hyperemia with congestion of the periarticular structures and synovia. If there is a severe injury, an exudation and hydrarthrosis forms which may disappear. If, however, this persists and is not absorbed, important modifications result. The bone becomes osteoporotic, the cartilage disintegrates, the synovial membrane becomes thickened and shows islands of cartilage formation; the periosteum lays down bone, and the general picture is that of deforming arthritis.

Kreuscher²² says that continual injury causes injection of the synovial membrane and cartilaginous surfaces followed by a serous effusion. Continuation of the trauma results in hemorrhage into the joint with tissue reaction and edema of the capsule. The joint is swollen and painful, but clears up if rest is instituted at this stage. If trauma continues, a definite fibrillation occurs with erosion of the surface cartilage and with villous degeneration of the edge of the synovial membrane. These changes are not uniform throughout the joint, but erosion may be seen at one place and overgrowth at another.

Axhausen⁸ believes that the injury must be severe enough to cause damage to the cartilage in order to produce arthritis deformans. He believes that hemarthrosis cannot be the cause of arthritis deformans, but that it can produce changes in the capsule and synovia by organization of the fibrin followed by fibrosis and contractures. He states that it is well known that patients with arthritis deformans react to slight trauma with the production of effusion into the joint.

Engelhardt⁸ also states that a definite

injury to the cartilage is necessary to produce arthritis deformans. It is not due to the injury of the cartilage itself, but is due to loss of elasticity of the cartilage secondary to circulatory disturbances. Small superficial cartilaginous necroses are secondary in nature and are not responsible for the development of the arthritis deformans which develops at the site of deeper necrotic cartilage.

Schmidt²⁶ believes that injury to the joint followed by exudation and failure of absorption of the deposit of fibrin can lead to proliferation of the synovia and secondary changes in the joint cartilage. Graesner¹⁶ also believes that hypertrophic arthritis may be a secondary result of trauma. In discussing this matter Blencke⁵ states that in the development of traumatic arthritis, a traumatic genesis can be accepted only when trauma was applied directly to the affected joint and was of sufficient severity to cause definite changes in the cartilage of the joint which is then followed, secondarily, by deforming changes.

Zollinger³⁰ is of the opinion that necrosis of cartilage does not necessarily lead to the typical findings of hypertrophic arthritis. It is likely to occur only in those cases in which there is very marked injury to the cartilage and blood vessels with long-standing disturbance of nutrition. Hemarthrosis in an otherwise normal joint cannot be considered as the cause of hypertrophic arthritis. Sonntag²⁷ states that the most common causes of cartilage damage are intra-articular fractures and dislocations, ligamentous tears, displacement or tear of the menisci, or breaking off of pieces of the cartilage itself.

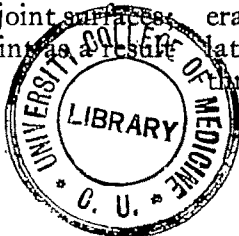
Key²⁰ states that the following types of injury may produce traumatic arthritis: (1) single severe injury to cartilage; (2) repeated mild injury to cartilage; (3) disorganization of the mechanics of the joint; (4) abnormal function in a joint on account of bony deformity so that use brings about repeated injury to the joint surfaces; (5) gradual deformity in a joint as a result of abnormal pressure.

All of these types of injury, however, resolve themselves into the first two types. Any type of deformity, foreign body, occupational trauma, infection, etc., that can produce cartilaginous injury may be followed by reactionary changes which are commonly called traumatic arthritis.

The earliest joint changes seen by Ewald¹¹ occurred in a knee six weeks after injury. This was known to be normal previous to injury. Sonntag²⁷ believes that arthritis can occur as early as four weeks after injury or may be delayed for years. It usually takes from three to six months to show clinical and roentgenological signs. Schmidt²⁶ states that arthritis due to static deformities usually does not occur later than two years after injury and that changes occurring many years later are to be disregarded. In the opinion of Zollinger,³⁰ the more severe the injury, the earlier will be the arthritic changes, and vice versa. Axhausen,³ after considering this question, concludes that one cannot set up hard and fast rules but that on the basis of clinical and roentgenological considerations, one must judge each case.

The progressive development of traumatic arthritis is quite similar to the changes seen in hypertrophic arthritis. In the early stages there is injection of the synovia and cartilaginous surfaces, and frequently a serous or bloody effusion is present. The joint is swollen and painful. If progression occurs, the articular surfaces become roughened and there is edema of the capsule. In the later stages both show disappearance of the joint cartilage, thickening and fibrosis of the capsule, synovial hypertrophy, and the production of osteophytes around the articular margins. Roentgenologically there is little difference to be seen between the two kinds of arthritis unless there has been demonstrable bone change at the time of injury or unless there is some structural deformity of the part.

Hypertrophic arthritis tends to be generalized and to have a gradual onset in the later decades of life, while traumatic arthritis usually is localized to one joint and



there must be a history of a definite injury or some long continued trauma to this particular joint.

The question of whether injury can cause an aggravation of an already existing arthritis is one that requires considerable study. One must distinguish between the acute symptoms that would naturally follow an injury to any joint whether arthritic or not, and the more lasting symptoms that might indicate that the course of an already existing arthritis had been accelerated.

Blencke⁵ believes that injury may aggravate an already existing arthritis and that this may occur with a less severe injury than is necessary to produce arthritis in a normal joint. Engelhardt,⁸ however, states that the same fundamental factors are present as in the case of a normal joint and that the injury must be just as severe as if the joint were normal. Zollinger³⁰ also believes that arthritis can be aggravated by trauma but that one must differentiate carefully between temporary acute painfulness and permanent aggravation. Sonntag²⁷ and Graessner¹⁶ are of the opinion that the injury must be of such magnitude as to be sufficient to cause arthritis in a healthy joint.

One must be very exact in considering the previous state of the arthritis in order to judge if the disability has increased. A number of follow-up examinations over a period of a year or more may be necessary in order to determine whether there is any increase in the permanent disability. In many cases there will be an acute syndrome with swelling of the joint, pain, limitation of motion, and muscular atrophy which, however, clears up after varying periods of time and leaves no appreciable increase in disability.

DISCUSSION

From the results of the experimental work and the clinical opinions quoted above, it is quite evident that certain pathological changes in and around joints may follow injury. The relation between these changes and hypertrophic arthritis

is, however, not so clear cut. There is considerable question as to whether these changes should go by the name of traumatic arthritis inasmuch as the word arthritis is associated in the popular mind with a chronic progressive disabling malady affecting the entire body. The reaction of a joint to injury, on the other hand, is usually a local condition and is more or less stationary in its development after a varying time interval. We raise the question of whether it would not be better to call these joint reactions which follow injury by some such name as chronic traumatic joint reactions unless we are willing to admit that trauma is the principal etiological factor in hypertrophic arthritis. However, in view of the generally accepted use of the term "traumatic arthritis," we have employed it in this communication.

It has been shown that these arthritic-like changes can be produced by either a single severe injury or by repeated lesser injuries. These may be produced by injuries such as intra-articular fractures, dislocations, injury to the cartilage or even to the soft parts. A good example of the pathology produced by chronic mild trauma is that of baseball pitcher's elbow as reported by Kreuscher.²² At operation he found changes very similar to hypertrophic arthritis. There was cartilaginous destruction combined with osseous proliferation and partial fixation of the joint.

Many authors believe that injury to cartilage is the underlying change in the production of traumatic arthritis and that the injury must be severe enough to produce cartilaginous injury if it is to be followed by traumatic arthritis. Arthritic changes, however, do not always occur when cartilaginous damage is produced and in those cases where immobilization is an added factor the process is much slower and there may be restoration of the original condition. This led Burckhardt⁷ to the conclusion that hypertrophic arthritis is due to regeneration after cartilaginous injury and is modified greatly by use or disuse of the joint.

The minimum time interval between injury and the development of the so-called traumatic arthritis has been given as four weeks. This, however, seems questionable and the usual time interval will be found to be from three to six months, and may be one year or longer. Many factors enter into this and it is difficult to lay down any definite time limit. It should be stated, however, that arthritis occurring several years after injury, with a long intervening normal period, should be looked upon as probably of non-traumatic origin and other causes should be sought.

In comparing hypertrophic arthritis and traumatic arthritis, one must remember that the word trauma as used here is a broad term and applies to mechanical injury and also to that more intangible form known as toxic injury. The mechanical form of injury may be a single severe injury which may or may not have been disabling at the time, or it may refer to static stresses and strains which produce long continued minor traumata to the joint. Evans⁹ points out that many of these undue stresses are produced by bodily conditions such as bad posture, obesity, and abnormal bodily metabolism. The spine is especially liable to show the effects of such types of strain, but unfortunately, the same roentgen findings are present in cases of hypertrophic arthritis of the spine, except that in hypertrophic arthritis they are likely to be more generalized. It is quite evident that hypertrophic arthritis and traumatic arthritis are similar roentgenologically, and that to differentiate them one must have recourse to the history and physical examination in addition to the films.

In the experimental work reviewed above the results are fairly constant and show that following a certain standard injury one may expect typical joint reactions in most of the animals. However, when one attempts to evaluate industrial injuries many complications are encountered. The injuries are varied and range from those which appear, on the surface, to be fig-

ments of the imagination to those which produce marked structural deformities. One must also consider the previous state of health especially from the standpoint of joint disability. A very careful history and complete physical examination, including the spine, are necessary. The roentgen examination, of course, is of paramount importance because by means of it the various changes can be shown which anatomically determine normal or disturbed function of the part. In a typical case of hypertrophic arthritis the pathology represented is that of cartilaginous destruction, increased density of the articular surfaces with marginal osteophytes, and thickening of the periarticular structures. These pathological changes are delineated more clearly on the roentgen film than by any other means at our command. One must be extremely careful about interpreting these physical changes into clinical symptoms as it is a well-known fact that many cases have been seen who have had these changes to a rather marked degree without experiencing any noticeable disability or subjective symptomatology. From a medico-legal aspect, there are various criteria which must be considered. If a joint disability is to be considered of traumatic origin, then an injury severe enough to produce cartilage damage must have been applied directly to the joint in question or it must be shown to have been caused by articular stress from structural deformity elsewhere. Proof of adequate injury must exist as all factory workers receive minor traumata. Generalized bodily injury is not considered an etiological factor in traumatic arthritis.

Zollinger³⁰ is skeptical as to the prevalence of traumatic arthritis and makes the pertinent remark that workmen always develop arthritis from injury while housewives develop it in the ordinary course of work without a history of injury. In his clinic, out of 124,000 cases with the same type of injury, they were able to establish a relation between trauma and hypertrophic arthritis in only 18 cases.

Before making a diagnosis of traumatic arthritis, it would seem that certain criteria should be complied with and these might be summarized as follows:

(1) There must be proof of injury and of its severity.

(2) The injury must have been applied directly to the joint in question.

(3) Information must be obtained as to the previous function of the joint in question.

(4) The time interval between injury and occurrence of pathological changes must be within the generally accepted limits.

(5) There must be clinical and roentgenological evidence of pathological tissue changes.

The question of aggravation of an already existing arthritis by trauma is one in which there is not at present a uniformity of opinion. It is generally accepted, however, that an injury of such magnitude as to produce arthritis in a normal joint will cause aggravation in one already showing arthritic changes.

Considerable care must be taken to distinguish between acute painfulness of the joint after injury and the more permanent changes that might indicate exaggeration of previously existing changes. In estimating disability one must determine how much disability existed before injury occurred, and compensation paid only until the previous state of use of the joint has been restored.

The roentgenologist is in considerable demand as an expert witness in cases such as these, and in fairness to himself and the contending parties, should not allow himself to become involved in the non-roentgenological aspects of the case unless he is also a qualified clinician and has had the opportunity to thoroughly examine the patient. He should be able to state, from the study of his films, whether there are tissue changes present, such as are seen in

cases of arthritis, bone reactions from injury, or deformities which might cause impairment of function. In cases which are negative for any evidence of bone or soft tissue change, he is justified in concluding that there is no roentgenological evidence of impairment of function. This does not mean to imply, however, that there may not be pain with disability in cases with slight changes. Fisher¹⁴ states that "it is impossible to estimate the probable severity of pain and other disability from the degree of osteo-arthritis present." He believes, moreover, "that in the absence of clinical signs and with an equivocal x-ray, a diagnosis of osteo-arthritis should only be made with the utmost diffidence; secondly, that in any given case x-ray evidence of osteo-arthritis combined with an absence of clinical signs are insufficient grounds for a ruling of total disability." It is evident, therefore, that the clinical aspects are extremely important and must always be evaluated in determining the amount of actual disability in these cases.

SUMMARY

1. Injury of sufficient severity to produce damage to cartilage is often followed by chronic tissue changes which are called traumatic arthritis.

2. It is difficult to distinguish these changes on the roentgenogram from those seen in cases of hypertrophic arthritis.

3. These joint reactions after trauma usually occur from three to six months after injury, but may be delayed for a year or more.

4. Aggravation of a pre-existing arthritis by trauma is to be assumed only after injury of sufficient intensity to cause changes in a normal joint.

5. Criteria for diagnosis of traumatic arthritis are outlined.

6. Consideration is given to the medico-legal aspects of the subject.*

* For discussion see page 49.

REFERENCES

1. AIEVOLI, E. Arthritic deformities from the point of view of compensation. *Riforma med.*, 1930, 46, 579.
2. AXHAUSEN, G. New research on the rôle of cartilage necrosis in the pathogenesis of arthritis deformans. *Arch. f. klin. Chir.*, 1914, 104, 301-346.
3. AXHAUSEN, G. Arthritis deformans. *Monatschr. f. Unfallh.*, 1926, 33, 245.
4. AXHAUSEN and PELS, I. Experimental work on the origin of arthritis deformans. *Deutsche Ztschr. f. Chir.*, 1911, 110, 515-531.
5. BLENCKE, A. The relationship between arthritis deformans and injury. *Arch. f. Orthop.*, 1930, 29, 26-66.
6. BONN, R. Arthritis deformans occurring after trauma to the hip joint. *Arch. f. klin. Chir.*, 1924, 129, 686-699.
7. BURCKHARDT, H. Experimental research on the relation of joint function to arthritis deformans. *Arch. f. klin. Chir.*, 1924, 132, 706-763.
8. ENGELHARDT. Theses regarding mediolegal obligation in arthritis deformans. *Ztschr. f. orthop. Chir.*, 1930, 53, 223-229.
9. EVANS, W. A. Roentgen findings as evidence in medico-legal cases. *J. Michigan M. Soc.*, 1931, 30, 329-339.
10. EWALD, P. Limited acknowledgment of arthritis deformans as due to accident. *München. med. Wchnschr.*, 1926, 73, 360-362.
11. EWALD, P. Can dicta be established in the question of arthritis deformans and injury. *Monatschr. f. Unfallh.*, 1929, 36, 173-177.
12. FISHER, A. G. T. A contribution to the pathology and etiology of osteo-arthritis. *Brit. J. Surg.*, 1922, 10, 52-80.
13. FISHER, A. G. T. Experimental production of acute and chronic arthritis and articular neoplasm by radium. *Brit. M. J.*, 1927, 1, 319-321.
14. FISHER, A. G. T. Chronic (Non-Tuberculous) Arthritis. The Macmillan Co., New York, 1929.
15. GOLDHAFT, A. D., WRIGHT, L. M., and PEMBERTON, R. The production of hypertrophic arthritis by interference with the blood supply. *Am. J. M. Sc.*, 1930, 180, 386-397.
16. GRAESSNER, R. Arthritis deformans and injury. *Monatschr. f. Unfallh.*, 1926, 33, 252.
17. HOLM. Consideration of the post-traumatic arthritides. *Ann. de méd. phys.*, 1930, 23, 145-148.
18. KEY, J. A. Traumatic arthritis and the mechanical factors in hypertrophic arthritis. *J. Lab. & Clin. Med.*, 1930, 15, 1145-1160.
19. KEY, J. A. Experimental arthritis; the changes in joints produced by creating defects in the articular cartilage. *J. Bone & Joint Surg.*, 1931, 13, 725-739.
20. KEY, J. A. Traumatic arthritis. *Arch. Phys. Therapy*, 1931, 12, 550-556.
21. KLINGE, F. Experimental production of arthritis deformans. *Verhandl. d. deutsch. path. Gesellsch.*, 1931, 26, 216-225.
22. KREUSCHER, P. H. Osteoarthritis, traumatic, of the elbow joint; special variety, baseball pitcher's elbow. *S. Clin. N. Amer.*, 1926, 6, 897-905.
23. KROH, F. Experimental arthritis deformans. *Deutsche Ztschr. f. Chir.*, 1909, 99, 425-443.
24. LERICHE, R. The problem of osteo-articular diseases of vasomotor origin. *J. Bone & Joint Surg.*, 1928, 10, 492-500.
25. MOULONGUET, P. Examples of arthritis deformans of traumatic origin. *Bull. et mém. Soc. nat. de chir.*, 1931, 57, 817-825.
26. SCHMIDT, G. W. Secondary arthritis deformans and injury. *Monatschr. f. Unfallh.*, 1929, 36, 177-182.
27. SONNTAG. Arthritis deformans and injury. *Deutsche Ztschr. f. Chir.*, 1930, 223, 222-235.
28. WEHNER, E. The significance of abnormal mechanical function in the pathogenesis of arthritis deformans. *Deutsche Ztschr. f. Chir.*, 1923, 180, 201-233.
29. WOLLENBERG, G. A. Etiology of arthritis deformans. *Arch. f. Orthop.*, 1909, 7, 226-234.
30. ZOLLINGER, F. Contribution to the question of the traumatic development of arthritis deformans. *Arch. f. Orthop.*, 1929, 27, 166-237.



LOCAL BONE ATROPHY*

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ATROPHY of bone may be general or local. General bone atrophy is chronic in character and affects the entire skeleton. It is caused by a lack of calcium in the food or by some abnormality in the calcium metabolism. Local bone atrophy may be acute or chronic and involves only the bones in a given portion of the body and is due to some local cause, and occurs in animals on an adequate calcium intake and with a normal calcium metabolism.

The atrophy is said to be eccentric when the bone is approximately normal in size and concentric when the bone is smaller than normal. The marrow canal of a long bone is increased in diameter in eccentric atrophy and is decreased in diameter in concentric atrophy. Eccentric atrophy is the result of resorption of part of the bone and in a long bone the cortex is not as thick as normal. Concentric atrophy is the result of retardation of growth and is caused by prolonged eccentric atrophy in a growing bone. In a long bone with concentric atrophy the thickness of the cortex depends upon the recent functional past of the bone. If the bone has been subjected to approximately normal use the cortex will be thick, but if the bone has been used relatively little the cortex will be thin.

It is further to be noted that eccentric atrophy is a temporary condition and the bone tends to return to normal after the cause of the atrophy ceases to act, but that concentric atrophy of any considerable degree tends to be permanent and if a growing bone is permitted to remain atrophic over a prolonged period so that growth is definitely retarded, it will tend to remain small throughout the life of the animal and, if the cause of the atrophy ceases to act, nature will attempt to compensate for the small size of the bone by increasing the thickness of the cortex.

ATROPHY OF DISUSE

To the physiological chemist the skeleton is the great calcium reservoir of the body, but to most of us the bones are the supporting structures which give strength and rigidity to the body, and their chief function is passive in that it consists of resisting mechanical forces. Generally speaking, function within physiologic limits, alternating with periods of rest, tends to cause a living organ to increase in size while lack of function tends to result in atrophy. Consequently, if a bone is not subjected to mechanical forces its function is lessened and we would expect the bone to atrophy from disuse.

As yet we have no satisfactory explanation as to why a bone which is not used tends to become resorbed. We do not even know whether the change in the bone is the result of increased resorption or of decreased formation of new bone. In order to view the problem in its proper perspective we must consider briefly the part which the skeleton plays in the metabolism of calcium. As a certain amount of calcium is excreted this calcium must be obtained from the food if calcium equilibrium is to be maintained. Sherman has shown that the normal adult human being requires 0.45 gm. of calcium daily and if this amount of available calcium is not present in the diet the calcium balance becomes negative. That is, more calcium is excreted than is ingested. This excess of calcium is withdrawn from the skeleton and this element can be withdrawn from the bones whenever needed by the general metabolism and is withdrawn whenever the calcium balance is negative. It is thus evident that a negative calcium balance leads to progressive generalized bone atrophy and if it were possible to maintain an animal on a negative calcium balance long enough the bones would

* From the Department of Surgery of the Washington University School of Medicine, St. Louis, Missouri. Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

tend to become completely decalcified.

If our histological criteria are reliable we may assume that even in an adult animal in a state of calcium equilibrium some resorption and some deposition of bone are constantly going on. This means that some of the ingested calcium is deposited as new bone, while some of the excreted calcium is withdrawn from the bone. There is thus a constant exchange of old for new calcium by an animal in a state of calcium equilibrium. It is, however, not possible to state whether a large or a small percentage of the ingested calcium is thus exchanged. Nor have we discovered how this exchange is regulated. The chemist would naturally expect this exchange to be regulated by chemical reactions and chemists have sought in vain for a satisfactory explanation of either the resorption or the deposition of bone in an adult animal in a state of calcium equilibrium.

Likewise, there is no satisfactory chemical explanation of the local atrophies which orthopedic surgeons are constantly encountering in their patients. Since no satisfactory chemical explanation is at hand we must assume that the deposition and resorption of bone depend upon the activity of living cells and that these cells can react to mechanical forces. We do not know how the exertion of mechanical force upon a bone can serve as a stimulus to the cells which control the formation of new bone, but experimental and clinical evidence indicate that new bone is formed in response to mechanical stimuli and is not formed in normal tissues if the mechanical stimuli are absent.

The evidence at hand also indicates that some bone resorption is constantly going on even in a normal adult animal on a normal diet. If it is true that new bone is not formed in the absence of mechanical stimuli, then atrophy of disuse may be simply the result of the normal bone resorption, since the maintenance of a normal bone structure depends upon an equilibrium between the normal rate of resorption and the deposition of new bone. However, it is

quite possible that disuse results in an increase in the rate of resorption and microscopic observations on bones which are undergoing atrophy from disuse suggest that this may be true.

The degree of the atrophy varies directly with the degree and duration of the inactivity, and Grey and Carr⁴ and Allison and Brooks¹ have shown that so far as the bone is concerned it makes practically no difference whether the inactivity is due to enforced rest in a plaster-of-Paris cast or to muscle paralysis and that the presence or absence of sensory nerves to the part does not influence the condition of the bone.

The mechanisms by which this resorption is accomplished have been discussed elsewhere (Key^{5,6}) and will not be repeated here. Suffice it to say that halisteresis does not occur in local bone atrophy and that the resorption is largely lacunar in type and that the lacunae contain osteoclasts. In atrophy of disuse the entire bone suffers and there is a gradual decrease in the size of the trabeculae and in the thickness of the cortex. As the atrophy continues to progress many trabeculae disappear entirely and the cortex may eventually become as thin as a sheet of heavy writing paper. This is not in accordance with the findings of Bauer, Aub, and Albright² who found that the bone trabeculae disappeared first and that the cortex suffered relatively little. However, the atrophy studied by these authors was due to lack of calcium in the food while the atrophy which we are considering is due to disuse and occurs regardless of the amount of calcium supplied to the organism. The discrepancy between their observations and the findings in both experimental and clinical atrophy of disuse may be explained by the fact that their animals were constantly using their extremities. As a result, that part of the bone was resorbed which could be spared while the cortex, which was being subjected to the mechanical forces incident to normal use, remained almost intact. This may be explained by assuming that function caused new bone to be formed in the cortex to re-

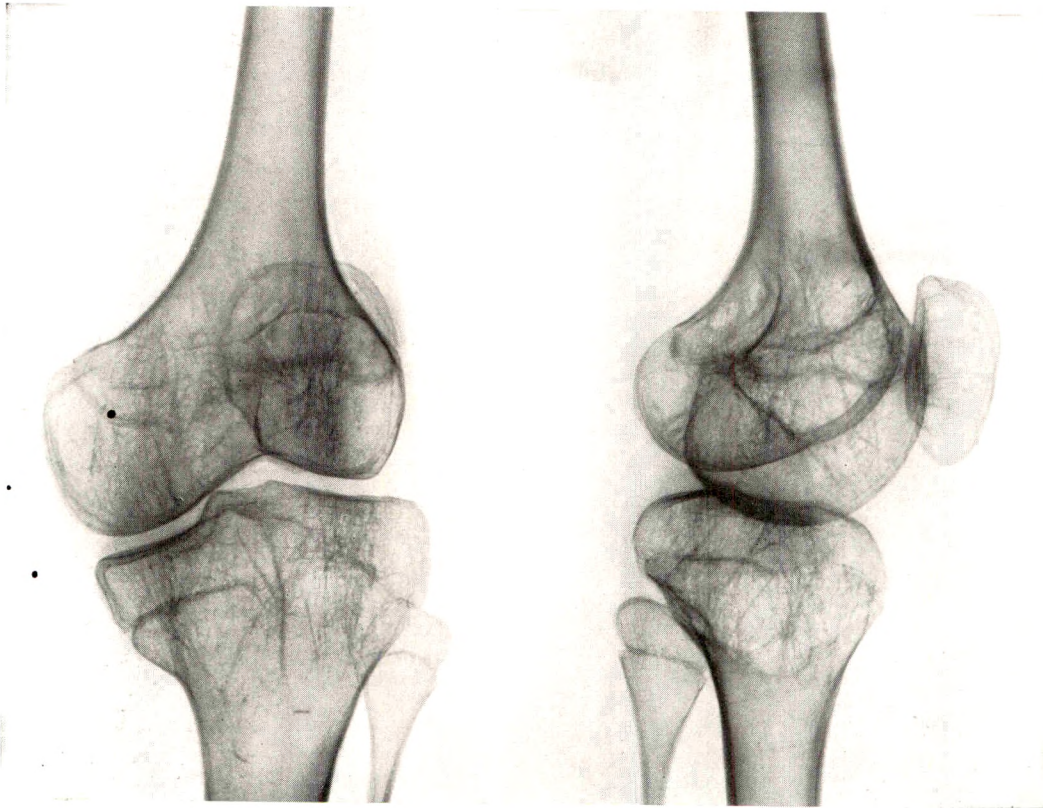


FIG. 1. Extreme concentric atrophy of disuse at the right knee joint in a girl sixteen years of age. This patient had spent the past four years in a tuberculosis sanitarium on a high calcium diet with this extremity immobilized by traction.

place that which was resorbed. If this occurred we should expect the shafts of the long bones to be stained with madder. But in their experiments the shafts of the long bones were stained very slightly. Consequently, I interpret their results as evidence that function tends to prevent resorption of bone even when the animal is on a negative calcium balance and that atrophy of disuse is probably due to increased resorption plus decreased new bone formation.

In the roentgenogram simple atrophy of disuse is first visualized as a diffuse decrease in the density of the involved bones. This is especially evident in cancellous bones and in the ends of long bones. As the rarefaction progresses the trabeculae stand out more clearly and the dense areas of the bones decrease in size. With further atrophy

changes in the cortex become visible and the trabeculae decrease in number so that the intertrabecular spaces become larger than normal. This is due to the gradual disappearance of many trabeculae. With extreme atrophy the cortex becomes progressively thinner and the trabeculae largely disappear so that a bone may appear as a faint shadow surrounded by a very thin cortical line enclosing a relatively small number of very faint trabeculae (Fig. 1). In simple atrophy of disuse there is no tendency for marked resorption to occur in localized areas and the mottling which occurs in acute atrophy is not seen.

ACUTE BONE ATROPHY

Acute bone atrophy may be divided into two groups: In one the atrophy occurs as a result of local inflammation or injury and

tends to disappear as soon as the cause is removed. The other is the so-called acute traumatic bone atrophy of Sudeck, and in this type the atrophy occurs after an injury and tends to persist over a considerable period of time.

The acute atrophy is partly due to disuse because the inflammation or injury interferes with the function of the part. However, observations on experimental animals and human subjects indicate that the bone atrophy progresses much more rapidly in injured or inflamed limbs than it does in normal limbs which have been paralyzed or immobilized in a plaster-of-Paris cast. These observations also indicate that the atrophy progresses more rapidly in acute



FIG. 2a. Marked acute atrophy due to gonorrheal arthritis, duration three months.



FIG. 2b. Same as Figure 2a. Anteroposterior view. The arrow points to what appears to be a deposit of calcium in the soft tissues.

infections than in chronic infections and in severe injuries than in minor injuries.

As yet we have no satisfactory explanation for this rapid resorption of living bone in the vicinity of an infection or injury. It is usually ascribed to the local increase in circulation which is brought about by the injury or infection. However, it can be accepted that thoracic or lumbar sympathectomy causes an increase in the circulation in the affected extremity; yet I was not able to detect bone atrophy in the sympathectomized limbs of a series of cats upon which Dr. Robert Moore and I had performed these operations. The same ar-

gument holds against local heat as being responsible for the accelerated bone resorption because sympathectomy causes an elevation of the temperature in the affected limb; yet I have some experimental evidence which indicates that local heat may increase the rate of atrophy of disuse. It is possible that acute bone atrophy is



FIG. 3. Acute atrophy in mid-tarsal region due to nonsuppurative arthritis of unknown etiology, possibly low grade streptococcic infection. Duration eight weeks.



FIG. 4. Acute atrophy present three months after a severe compound fracture of both bones of the leg. This patient has been in a plaster-of-Paris cast during this period.

due to some unknown chemical change in the tissues.

A familiar and very striking example of acute bone atrophy is that which occurs as a result of gonorrheal arthritis. With an acute gonorrheal joint the bone resorption occurs very rapidly and a roentgenogram taken four weeks after the onset usually shows marked rarefaction of the ends of the bones entering into the formation of the involved joint. This is especially true of those cases in which the disease is accompanied by edema of the periarticular tissues with marked tenderness, pain and local heat (Fig. 2). The same is true of an acute pyogenic joint or of a fulminating pyogenic infection of the bone or in the soft parts around the bone. One occasionally sees an acute arthritis which is apparently infectious in nature and the clinical picture of which resembles very closely gonorrheal arthritis and in such cases we find the same type of acute bone atrophy as occurs in the acute gonorrheal arthritis (Fig. 3).

fulminating tuberculous joints the bone atrophy may progress rapidly and be comparable to that which occurs in an acute pyogenic infection. As the disease may continue over a period of years and imposes long periods of disuse upon the extremity the bone atrophy may be extreme. Much the same is true of the bone atrophy which is such a prominent feature in chronic atrophic (rheumatoid or proliferative) arthritis.

In fractures the bone atrophy is largely the result of the disuse incident to the injury, but it is often acute in type and more marked than one would expect to occur from simple immobilization (Fig. 4). The acute bone atrophy which follows freezing or burning of an extremity resembles that which follows fractures and is probably due to the injury and infection rather than to any specific effect on the bone.

Roentgenographically, acute bone atrophy differs from the simple atrophy of disuse in that it is more sharply localized to the area immediately adjacent to the in-

fection or injury and in that it is less uniform in character. The bone frequently contains circumscribed areas of rarefaction in which the resorption has been greater than in the surrounding bone. This gives the bone a mottled appearance. This mottling is evidence of acute atrophy and in most instances occurs in the relatively early stages. Usually the roentgenogram is foggy or hazy and the outlines of the bones are not sharply defined. This is due to the local edema and thickening of the soft tissues which are usually present in acute bone atrophy. Very rarely small opaque masses may be present in the soft tissues and the roentgenogram suggests that calcium salts may have been withdrawn from the bone and deposited in the adjacent soft tissue (Fig. 2). After the atrophy has been going on for a relatively long period of time and the resorption is very marked the atrophy becomes diffuse and the roentgen picture resembles that of prolonged simple atrophy of disuse.

ACUTE TRAUMATIC ATROPHY OF SUDECK

This is a rare condition which is usually called Sudeck's atrophy because it was first adequately described by him in 1900.⁷ It may occur after a severe injury or it may

occur after a minor injury such as a sprain or contusion of the knee or ankle. After the injury the joint involved and the parts distal to it remain cold, cyanotic and painful. There is marked limitation of motion of the joints and this limitation of motion may be progressive. The roentgenogram shows an acute atrophy of the bone such as was described above and this may be well marked within a period of four weeks after the injury. This type of atrophy may persist over a period of many months, and lead to great disability and to eventual ankylosis of the involved joints. Sudeck believed that the acute atrophy was caused by some reflex neurotrophic phenomenon. A discussion of the various theories which have been advanced in an attempt to explain Sudeck's atrophy is given by Beck,⁸ but as yet we have no satisfactory explanation of the condition (Key⁶).

CONCLUSIONS

Chronic local atrophy of bone may occur from disuse and is not due to or markedly influenced by the calcium intake or calcium metabolism. Acute local atrophy of bone is the result of disuse plus some as yet unknown local factor.*

* For discussion see page 49.

REFERENCES

1. ALLISON, N., and BROOKS, B. Bone atrophy, an experimental and clinical study of changes in bone which result from non-use. *Surg., Gynec. & Obst.*, 1921, 33, 250.
2. BAUER, W., AUB, J. C., and ALBRIGHT, F. Studies of calcium and phosphorus metabolism. V. A study of the bone trabeculae as a readily available reserve supply of calcium. *J. Exper. M.*, 1929, 49, 145-161.
3. BECK, O. Die pathologische Anatomie und spezielle Pathologie der Knochenatrophie. *Ergebn. d. Chir. u. Orthop.*, 1925, 18, 556-689.
4. GREY, E. G., and CARR, GLADYS L. An experimental study of the factors responsible for non-infectious bone atrophy. *Johns Hopkins Hosp. Bull.*, 1915, 26, 381-385.
5. KEY, J. ALBERT. Bone atrophy and absorption. *Internat. J. Orthodontia*, 1929, 15, 949-982.
6. KEY, J. ALBERT. Factors in atrophy of bone. *J. Am. Dent. Ass.*, 1930, 17, 1660-1669.
7. SUDECK, P. Ueber die acute entzündliche Knochenatrophie. *Arch. f. klin. Chir.*, 1900, 62, 147-156.



THE ANATOMICAL BASIS FOR DISTURBED FUNCTION IN EVALUATION OF PERMANENT DISABILITY*

By HENRY H. KESSLER, A.M., M.D., F.A.C.S.

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THE enactment of workmen's compensation has introduced new social obligations for the physician. In addition to the management and treatment of accidental injuries he must prognosticate the effects of those injuries on the earning and working capacity of the injured. These prognostications must be translated into mathematical percentages, since the compensation paid to the injured is based on these percentages.

The determination of the percentage of permanent disability following industrial accidents is an important function of the medical adviser to the Workmen's Compensation Bureau. The amount of compensation that the injured worker receives depends upon these estimates. These determinations must be made by the examiner in the larger number of cases, since the schedule rating in the law provides only for absolute disabilities such as complete paralysis or blindness, cases of amputation, or total loss of use of a member. The partial disabilities which form the larger number of cases are not described in the law, and it is the task of the examiner to determine the disability resulting from these injuries.

It is the usual procedure in most compensation courts and commissions to have several physicians in the same cases estimate differently, and they often show discrepancies from zero to 100 per cent. In a recent case of a young woman with a fracture of the upper third of the femur with some shortening and limitation of the motion of the knee, some disturbance of gait, the attending physician who treated her estimated a disability of 80 per cent loss of use of the leg; the insurance physician estimated 40 per cent; when the attending physician was asked just why he estimated

80 per cent, he replied, "For the same reason that the other physician estimated 40 per cent; as a matter of fact, we are both guessing."

The methods in use throughout the United States differ greatly. Earning capacity, vocational utility, structural defect, cosmetic impairment are all given consideration in the different methods of rating. No universal standard has been accepted although I have long advanced the recommendation that only functional disability should be used as a basis of determining disability.

I believe that functional loss is the most readily adapted criterion and basis for estimating disability, because it can be used for the purpose of measuring. And since we are asked to measure, here is something with which to measure. What can a limb do? How far can it move? One can see just how far the arc of movement is impaired. One can determine how far average muscle power is impaired. One can ascertain just how far coordination has been interfered with.

Now the word "function" requires a little definition. Here again we may not all be meaning the same thing when we say function. Function to one may mean motion; to another it may mean coordination and it may also mean power, and to still a fourth it may mean the summation and the resultant of these three factors.

If we take an extremity like the arm and define function, we will define it in these three physiological terms: movement of the joints, power of the muscles and coordination and control from the brain through the peripheral nerves.

A man with a very mild weakness in the arm following a nerve injury might have complete range of motion, yet due to the

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

marked impairment of power and impairment of coordination may be handicapped. Where joint motion is limited but a fairly good arc of movement is retained, the injured worker may have much more power than others with even less limitation of motion.

Any type of arthrometer which is fairly accurate should be used to measure range of motion. For measuring strength we find that the older method of using the spring dynamometer is not very accurate because it depends upon the voluntary control of the patient. We find that it is very inaccurate, because if there is no cooperation on the part of the patient he can give you as little or as much as he wishes. Furthermore, in testing out a large number of individuals, I have found such a wide variation that in one man who was practically moribund and who was suffering from extensive generalized tuberculosis with amyloid changes of the liver and spleen, I obtained the highest reading, while a truck driver gave me the lowest reading. Neither of these was a compensation or a litigation case. We have had recourse to the Martin spring balance for our use. In 1916 this balance was used by Martin and Lovett in examining a large group of cases of infantile paralysis and they found it very effective, because it can be used to a large extent without expecting a great deal of cooperation on the part of the patient. By that I mean that it is used in such a fashion that it registers the resistance of muscle pull rather than a voluntary movement of muscle.

Tests of coordination are many and varied. The psychologists, for the most part, have developed them. For a long time I, too, was under the illusion that a right-armed man had a stronger arm in the right side than the left, but I have learned since that it is not so much strength that causes the difference between the two, but a difference in coordination. The ability of a prize fighter to hit a target, his opponent on the chin, with the right arm is due not so much to strength as it is to coordination.

There are a great many tests for determining this peculiar aptitude or attribute. A very simple one is a peg hole test which depends upon the individual placing 28 or more little pegs in holes with one hand and counting the time and comparing it to the other hand.

With the use of apparatus to measure the range of motion of the joints of the arm, the power of the muscle groups and coordination, we now proceed to the determination of functional disability. The upper extremity is divided into two units or radicals, the arm unit or radical and the hand unit or radical. The functions of these two units are essentially different. That of the arm radical may be compared to the action of a compound lever, permitting the hand radical or grasping tool to gain access to objects.

Motion, power and coordination are determined for the arm radical in the following way. The arm is divided into three major joints: shoulder, elbow and wrist. We ascribe arbitrarily a value of $33\frac{1}{3}$ per cent to each joint. We do not know—it is impossible to know, except for specific vocational purposes—what the relative value of each joint is. We therefore have to resort to more or less arbitrary principles in establishing a value for each joint. Let us say that the shoulder is restricted one-half its normal range. We ascribe, therefore, a value of one-half of $33\frac{1}{3}$ per cent, or 17 per cent. This 17 per cent represents the loss of motion for the arm radical.

The loss of strength is measured by the spring balance and is found to be 11 per cent and loss of coordination to be 7 per cent.

Now, again, we do not know which of these functional factors is most important and we do not know whether they ought to be added or multiplied. We utilize the largest factor of functional disability as a factor of disability for the entire arm radical, and in this particular instance it will be 17 per cent.

In evaluating the function of disability of the hand we realize that the hand is very

much like various types of tools. By the action of the thumb against the fingers the hand simulates the action of a pair of pliers.

Again, the function or physiological action of the hand and fingers may simulate that of a ring.

The apposition of the thumb to the index finger simulates the action of a pair of forceps, with its fine movement.

And, finally, in the carrying of objects in the folds of the fingers the hand simulates the action of a hook.

So we have these four mechanical analogues. However, we can still further translate these mechanical analogues into three definite functions of the hand: (1) the grasping power for small objects between the folds of the fingers themselves; (2) the grasping power for large objects between the fingers and the palm; (3) the apposition between the thumb and the tips of the fingers. Here, too, we ascribe a value of one-third to each function. If a man is unable to grasp an object between the folds of his fingers, we immediately ascribe a disability of $33\frac{1}{3}$ per cent of the hand. If he has also lost the ability to grasp large objects between the flat surfaces of his fingers and the palm, that is another third, or two-thirds. And if he is unable to oppose the thumb to the tips of the fingers, that very important function of apposition, then he has lost the other third.

Let us assume we have a case of a fractured head of the radius with poor position. We find the arm radical, that lever portion of the upper extremity, is disabled to the extent of 24 per cent. That 24 per cent may be due to impairment of power or impairment of motion, most likely motion in the elbow joint, yet the hand radical is not impaired to any extent; motion of the fingers is unrestricted; ability to grasp large objects in apposition is unrestricted; therefore, the hand radical is not involved. We then ascribe a disability of the entire arm of 24 per cent. We proceed on the theory that the chain is as strong as its weakest link; in this particular case the arm radical

is the weakest link, and is disabled to the extent of 24 per cent.

We may have a Colles' fracture with a poor reduction. The arm radical, as far as the wrist motion goes, may be impaired only 12 per cent. The hand radical, due to some flexion involvement with resultant inability to oppose objects between the folds of the fingers adequately, is disabled much more than the arm radical. We do not add these two values. We ascribe a value to the entire extremity equal to that of the greatest disability of the two radicals, or 20 per cent.

In the case of a compound fracture of the elbow with involvement of the ulnar nerve, there may be limitation of motion equivalent to 18 per cent. The hand radical due to sensory disturbance, contraction deformities of the last two fingers, probably paralysis of the extensor muscles of the hand, atrophy and weakness may give a 40 per cent disability of the hand radical. Here, too, we take the larger disability of the two as the one for the entire extremity.

In a fracture of the metacarpals with poor position and some shortening, the arm radical has no disability, no limitation of motion in the shoulder, elbow or wrist. There is no gross involvement of the power of the shoulder, arm or forearm muscle group, and there may or may not be gross involvement or coordination of the upper and forearm muscles. But the hand radical is definitely impaired due to the fact that there is some inability to grasp objects between the folds of the fingers.

Head injuries, back injuries, chest injuries and all other injuries, with the exception of the extremities, are very difficult to estimate. Yet they, too, must be computed if the injured man is to get his just award.

We have found another way of determining that man's physiological disability. We determine that disability through the use of a workshop where these men are put to work at various processes from the very lightest processes to the heaviest of operations. The shop is fitted out as a carpentry

DISCUSSION OF SYMPOSIUM ON INDUSTRIAL AND MEDICOLEGAL PRACTICE*

DR. E. C. SAMUEL, New Orleans, La. In our consideration of industrial medicine in its medicolegal aspects, we incline largely to the consequences of accidents rather than to their elimination. What is being done to avoid accidents remains largely along the lines of safety devices, safety campaigns, etc. And yet how very readily may equally important progress be made in the prevention or elimination of disability by comparatively simple means in avoiding undue physical risks in the personnel accepted for employment. Progress of such nature can be quite as valuable as the most efficient rehabilitation following an injury. And, in any routine of pre-employment physical examinations, it is the roentgenological part which will most frequently afford tangible evidence of value in deciding suitability for employment.

Any illustrative examples I may offer are superfluous to us with our knowledge of the revelations of our work but the more we drive home at every opportunity the lessons of such preliminary surveys the more quickly, I hope, may this survey become an accessory of the employment department of industry. (Dr. Samuel showed slides of several illustrative cases.)

One could continue indefinitely with such illustrative examples but I am hopeful that the time may come when as much may be accomplished in eliminating undesirable employment risks as we have already done by safety campaigns and improved treatment.

DR. C. S. GORSLINE, Battle Creek, Mich. A few things have been brought out this afternoon that I would like to emphasize. In regard to injuries to various parts of the body, I was hoping that some one would bring out this one particular feature that a roentgenologist should always bear in mind and that has helped me very materially in a great many cases: that is, where certain conditions are alleged and even shown in one part of the body it is always a very good point to x-ray the similar area on the opposite side. I have in mind the case of a knee injury which was rather doubtful. The man complained of great disability and traumatic arthritis. The case was awarded in the first instance. Later I happened to come into the case. I sized the man up, and I x-rayed the opposite knee. I found he had a more extensive proliferative arthritis in the right knee than he did in the left knee of which he complained. In fact,

it was only a short time later when the adjuster from the insurance company went into the country to locate him that he was working on soft ground. He was not favoring his limb at all, but as soon as he saw the adjuster coming across the ploughed field, he started to limp.

In regard to the matter of traumatic tumor, I believe that the Board in Michigan has improved in the character of their decisions and in their impartiality. However, I have one distinct case in mind where some three years before the second claim was put in I amputated three fingers, I think one completely and two partially, for a machine injury. About three years after his injury a tumor appeared about the mid-third of the humerus of the same arm. I believe that was determined to be a sarcoma. A resection of the humerus was done, I think at the University Hospital. About a year later he asked to have his case reopened because he had lost the use of his hand. His compensation had been specific on the loss of his fingers. The case was brought to the Board, and he was allowed loss of the use of the hand, whereas his loss was based upon the resection of the humerus and the hand showed no further change up to the time the tumor appeared. After getting that entering wedge I understand that the case is now to be reopened again with a view to getting compensation for the loss of an arm, and if that was a sarcoma a death claim is in the offing. I do not see where there is any connection after three years between a sarcoma of the humerus and the amputation of three fingers.

I do not agree with Mr. Rhoads in regard to medical representation upon the Industrial Board of this state. I have talked with Mr. Rhoads personally in regard to the matter, and I think the case that I have just cited is one evidence at least why we should have competent medical representation upon the Industrial Accident Board, so that a better interpretation may be made of the evidence that comes in. It is twenty years this month since the compensation law went into effect in Michigan. I have had more or less familiarity with it since, and one has only to listen to some of the questions that some of the deputies ask to know that what is being sought after is being missed entirely. I think, that the law in Michigan is now administered better than ever, but I think certain improvements should be made.

* Papers of Drs. Gillies, Sante, Hartman, Doub, Key, Kessler, Foster, and Rhoads.

In Dr. Key's article I am impressed with one point that he made, especially in regard to traumatic neurosis, that being the extreme case. That is, that the measure of the success you have in getting your people back to work is measured by the cooperation of the employer. One firm that I have been privileged to serve for a number of years has not for years had a hearing brought up before the Commission with regard to getting a man back to work. It is simply because they have listened to what I have tried to advise them, and have cooperated in giving the man suitable work and encouragement.

DR. H. J. WALTON, Baltimore, Md. Just a word in regard to Dr. Key's remarks about disuse atrophy. I feel that this decalcification is largely a pressure atrophy. It takes but little pressure upon normal bone to produce roentgenographic changes in its structure. This is easily demonstrated in cortical brain tumors, or where there is increased intracranial tension, either general or local.

In the treatment of fractures, the question has frequently been asked why marked decalcification occurs in one instance, and in another the bones show practically no change. I think this can easily be explained by the amount of swelling that occurs in the soft tissues from the tightness with which the splints and bandages are applied. We have all noticed the extreme decalcification that frequently occurs, especially in bones of the lower extremities where there is marked edema, and this increased porosity will continue as long as swelling lasts.

DR. KEY (*closing*). In answer to the question on pressure atrophy. I did not mention that because I believe that pressure may cause local

resorption of bone and I differentiate between local atrophy and local resorption. In this paper I limited my remarks to bone atrophy. In previous publications I have shown that local pressure may cause either resorption or new formation of bone and that at present we are not in a position to explain why in one instance the bone is resorbed while in another instance it hypertrophies as a result of pressure.

DR. KESSLER (*closing*). The subjects that were under consideration today before your Society have been my daily problem for the last twelve years. They have been considered from the clinical, pathological and experimental side. The question of the relation between injury and disease might also be approached from a statistical point of view. I personally have had occasion to examine more than 75,000 cases of injury, and in that large number I have failed to find that relation between injury and disease which some authors have claimed. For example, in this entire series I have not had more than 35 cases claim compensation for malignancy, and of those cases only 19 were compensated. This is a small number to result from trauma. A very small number of cases without any reasonable degree of doubt show a relation between injury and disease. As a matter of fact, the number of claims for traumatic tuberculosis was less than the normal incidence of tuberculosis in the entire population. The question of the relation between injury and disease and the determination of the temporary and permanent disability period is becoming more and more the problem of the average physician as well as of the expert. The very fact that these questions are brought before an organization such as this shows great progress



case for a period of time. During this period a complete investigation must be made of all the phases of the patient's life, other than industrial, in an effort to uncover some other situation that has been the precipitating factor. This is extremely difficult because of the fact that a neurosis is primarily a defensive mechanism, not against doing work, but against life in general to which he has found difficulty in adjusting himself. The defensive mechanism together with a tangible concrete cause fixed in the patient's mind, namely, the accident, offers a large obstacle to overcome. It usually results in the patient having a mental block against any unravelling of his subconscious mind. As a result, considerable time is necessary to make any appreciable headway.

The real origin of the neurosis aside from the injury may be purely avarice, which may be encouraged by friends, relatives and attorneys, or it may be a fear produced by a wrong medical diagnosis as well as a situation far remote from the accident. In regard to avarice, it should be remembered that symptoms may begin as pure malingering but later change to a true hysteria or neurosis through suggestion.

In the differential diagnosis of traumatic neurosis, we must consider most of all, true hysteria, post-concussion syndrome, and malingering. Hysterical pains, paralysis, contractures, etc., differ from traumatic neurosis in that the emotional instability is practically negligible, tremors and increased tendon reflexes are not present and vasomotor disturbances are rarely present. The usual picture in hysteria is a localized complaint that is purely ideogenous and rarely is there any generalized reaction. This, with the stigmata of hysteria, suffices to differentiate the two conditions.

The post-concussion syndromes are easily differentiated by the nature of the complaints, namely, headache, head noises, attacks of dizziness and occasionally increase in the spinal fluid pressure with relief of symptoms following a spinal drainage. Encephalography is also helpful in diagnosis.

Malingering, of course, offers the greatest problem in the differential diagnosis of a neurosis in industrial and legal medicine. As I stated above, if the signs of a neurosis are strictly adhered to for a diagnosis, the question of malingering will arise most infrequently. In those cases in which there is doubt regarding the genuineness of the symptoms, the claimant must be closely observed throughout the day for evidence of malingering. Placement in a sanitarium may be necessary for this procedure. I, personally, satisfy myself by not considering any case one of traumatic neurosis unless conclusive signs are shown because a neurosis is an entity and the borderline cases are usually the ones who have either begun as malingerers and through suggestion have produced certain functional disturbances in themselves or are malingerers at the time of the examination. I believe that the medical profession should be out of sympathy with any case in which there is a definite conscious element.

The treatment of traumatic neurosis is a most difficult problem, especially in industrial medicine, because of the compensation that is received and the length of time a case is usually allowed to go before a diagnosis is made. An early diagnosis and settlement are absolutely essential if good results are to be obtained. To allow a case to become long standing will tend to encourage any symptoms that may start as malingering to change over to a functional disturbance. The periodic check from the employer or his insurer in a bona fide case is the same as handing him a note saying he is still incapacitated. So an early diagnosis and complete and final settlement are the two most necessary points before instituting other forms of therapy. In spite of a lump sum settlement, there are some cases that do not improve, even though the most careful treatment has been instituted.

CASE. F. S., aged sixty, was examined on August 11, 1932. The previous medical history, family history and marital history were entirely negative and had no bearing on his complaints, which consisted of pain in the right

shoulder, difficulty in the use of the right upper extremity and pain in the right side of the head. He alleged that these complaints had persisted ever since he was jammed between a door and wall on May 5, 1931, while employed by a lumber company. He was placed on physiotherapy, treatments being given at intervals of two to seven days until April 6, 1932, when he was denied further compensation. Compensation was denied because a letter was produced which the patient had written on May 12, 1931. This letter was an application for work with another lumber company in which he stated he was able to do any kind of work.

The case was reopened because the employee filed a claim that his complaints were worse and he was then sent for a neurological examination. The examination was entirely negative for organic disease other than rather marked signs of senility. The patient was definitely depressed and showed a marked flushing of face and neck. There were numerous facial tics. The right grip was weaker than the left and all movements of the left upper extremity were limited and weak. All forms of sensation were alleged to be diminished on the right side of the body with the change in exactly the mid-line. All tendon reflexes were definitely increased and there was a fine tremor of the hands on extension.

The above signs are characteristic of a neurosis, but the concrete evidence presented left no doubt about the condition starting as pure malingering. The complaints were then encouraged by routine physiotherapy without a proper analysis of the case, with the neurosis as a result.

After litigation is completed, the treatment consists of placing the individual in an environment away from all outside influences, institution of physiotherapy and suggestion therapy and building up his confidence through a gradual increase in his daily duties. Where a case cannot be closed beyond reopening, such as is the situation in Michigan, different steps must be taken. The ideal treatment would consist in placing the patient away from his sympathetic home environment, his physician having complete charge of the case so there would be no contacts between patient and insurance adjuster, and the cooperation of the

employer in helping to adjust the employee. The reason for avoiding a sympathetic environment is quite evident. To avoid contacts with insurance company representatives is to avoid the building up of defensive mechanisms against a return to work. Every time the patient has an interview with an adjuster, he is sure to be asked when he is going to return to work and will sense an antagonistic attitude. This should be avoided and, as a matter of fact, the patient should be made to feel that he is not being pushed, that a corporation has, after all, a human side. This latter is shown by making him feel that everything possible is being done through consultations for assurance, by allowing him to take a vacation if he desires, and so forth.

The cooperation of the employer in getting the patient back at work is necessary because any industrial conflicts must be removed, and, as a rule, work of a different nature must be supplied. A gradual increase in the demands is instituted, but under no consideration should he be given a type of employment that marks him a cripple. Of course, no case of traumatic neurosis will become adjusted if the individual feels that after his return to work he is to be laid off in a short while or if he feels that he is to receive some other form of punishment. This latter angle is the greatest obstacle in treating a neurosis because the patient has, no doubt, built up a defensive mechanism due to present lack of employment. A lump sum settlement of the case beyond reopening would therefore be a change most welcome to the physicians as well as to the employers and their representatives. This would be material aid in effecting an adjustment of the patient. In closing, allow me to repeat that the problem which traumatic neurosis offers today would be greatly simplified if the term were applied only to those cases which have the classical signs of a neurosis.*

* For discussion see page 49.

THE ROENTGEN-RAY AND MEDICAL EXPERT IN THE HEARING OF COMPENSATION CASES*

By SAMUEL H. RHOADS
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AN EMINENT English jurist has said, referring to the Compensation Law, that:

"The few and seemingly simple words 'arising out of and in the course of the employment' have been the fruitful (or fruitless) source of a mass of decisions, turning upon nice distinctions and supported by refinements so subtle as to leave the mind of the reader in a maze of confusion."

The administration of the Workmen's Compensation Law has become a highly specialized branch of legal-medical jurisprudence. The general practitioner, either in law or medicine, soon finds himself in this "maze of confusion" when confronted by the highly trained expert in either field. It necessarily means expense to employ skill in any law suit. More legal aid is perhaps given injured workmen and their dependents in compensation cases than in any other field of litigation. Because of this situation, a greater responsibility is placed on the expert. After several years on the Commission, and an examination of hundreds of cases where experts have testified, I can say that as a rule the roentgen-ray and medical expert has given his honest opinion as to the causal connection between the accident and the disability.

The human body is a very complicated and wonderful piece of creation. It has been said that a person is as old as his arteries. The heart beat, the blood pressure, and the temperature are some of the gauges which indicate to the trained mind certain conditions of the body. Medical science has made wonderful progress in diagnosing human ills and the roentgen-ray with its trained specialist has been a great aid. In fact, the roentgen ray is an indispensable aid. Certain diagnoses would not be possi-

ble without it. It has saved human life, because with it the diagnostician and surgeon are guided in their treatment and operations. But like any other science it must be under the control of an expert. The taking of the roentgenogram is important, but the interpretation is more important. In weighing the testimony in a case, the skill and experience of the interpreter of the x-ray must be taken into consideration. The ordinary physician and surgeon can discover fractures and the common abnormalities, but diseases of the bone, heart and lungs, out of the ordinary, require the services of the roentgenologist and pathologist for a proper diagnosis. It has been said that a little knowledge is dangerous. This is particularly true when it comes to the roentgen ray. The testimony of some cases, where a doctor with a limited experience has taken x-ray pictures and is attempting to interpret them, is ludicrous. Such information may mislead the Commission and lead to a miscarriage of justice.

For example, take the case of cancer. I have never yet heard a real expert say he knew the cause, but many times some physician limited in experience will express an opinion which may mislead the Commission. The Commission must follow the evidence. The end should not be to assist one of the litigants, which is often the case where the witness is not qualified in a field where he has entered, but to testify as a scientist rather than an advocate.

Traumatic neurosis seems to be a convenient place to assign the patient when no pathological basis can be found for the disability. While I realize that the mental attitude, when coupled with an accident, is an important factor, yet this alleged

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

disability of traumatic neurosis must, in my opinion, be watched very carefully. It is much overdone. In one case, a witness from a state university, a leader in his profession, testified as follows:

Q. What is a traumatic-neurosis?

A. A traumatic neurosis means the result of a person of a peculiar type of mind, the sort of a person who under strain and stress, is likely to break down, in those people injury will produce, the exaggeration of the symptoms, exactly the same as people that had shell-shock overseas.

Q. It is just as much of a disability as though it was an actual material fact, if it affects the mind that way?

A. It depends on how much it is connected with questions of litigation.

Q. With what?

A. With questions of litigation.

Q. Well in the absence of litigation?

A. You very rarely see it in the absence of litigation.

The x-ray in the hands of an expert assists the diagnostician to avoid medical absurdities. A miscarriage of justice is a legal tragedy. It strikes at the foundation of government. Such a catastrophe should always be avoided wherever possible. The x-ray should be in the hands of the roentgenologist when it comes into the field of litigation. Sometimes it is suggested that a physician as a member of the Commission would be of service. I do not think so. Better keep the judge in his place and the expert witness in his. The business of weighing testimony, expert as well as lay, and determining the facts, applying the rules of law, is the function of a judge. He constructs the eternal building of the law out of the material brought to him. If poor material is brought, the defect is seen in the structure.

The Compensation Law is complicated. It is complicated because it deals with a complicated subject. Accidents and their

many phases in relation to employment, the causal connection between the accident and the disability, the human body and its attendant ailments, all of these phases lead us into fields of the most puzzling complications.

As previously stated, the medical expert, and especially the roentgenologist, is of great assistance to the Commission, in fact, an indispensable aid in many cases. But he should not leave his high calling as a scientist to assume the rôle of the advocate. The moment he commits this judicial sin, the value of his testimony as an unbiased expert is destroyed. The judge who is trained in weighing testimony and argument senses a matter of this character quickly. When he does, his confidence in the witness is destroyed. He can easily find judicial reason to eliminate the witness, and usually does so in a very noticeable manner. It is too great a price for any expert to pay for the result of any case, because he endangers his future usefulness in his chosen field. He should appear for the opposite side from that for which he usually testifies, occasionally, as a check on his mental attitude. As a judge should seek to maintain a perfect judicial attitude, remembering only the evidence and the law, so should the expert witness remember only his science.

I believe the medical and roentgen-ray experts who are testifying in cases before this Commission are doing their best to uphold this standard. The Commission will continue to have confidence in them as long as they do. The roentgen ray has great possibilities in fields yet unexplored. It has made wonderful progress in the last twenty-five years. What the next twenty-five will be we do not know, but can only imagine. Yours is an interesting science of great benefit to humanity. March on to greater achievements, and may the glory of your progress inspire you to do your best.

NON-OPAQUE FOREIGN BODIES IN THE BRONCHIAL TREE

REPORT OF THREE CASES

By ROBERT C. PENDERGRASS, M.D.

AMERICUS, GEORGIA

THE detection of opaque foreign bodies in the tracheobronchial tree by roentgenologic examination offers no difficulty, but non-opaque foreign bodies in this location often present serious diagnostic problems.

The history of aspirating a foreign body is not always obtainable, for obvious reasons. A coughing or choking attack may cause the parents to suspect that something has been aspirated, but if the attack subsides readily, the incident is soon forgotten, and in many cases no medical aid is sought. More anxious parents may carry the child to a physician who makes a roentgen examination of the chest, sees no foreign body, and dismisses the case. Later, that child may be returned with a history of fever, cough, or "chest cold," and be found to present definite physical signs of lung pathology. From the history and physical findings, a diagnosis of bronchitis, tuberculosis, or bronchopneumonia may be made. A second roentgen examination may reveal evidence of bronchial obstruction with the accompanying lung changes. It is important that such changes be recognized in order that bronchoscopy may be done.

In other instances, the results of bronchial obstruction by a non-opaque foreign body may be so acute in their onset and symptoms that a diagnosis of pneumonia is made and the patient treated accordingly. This is especially apt to occur if the history contains no suspicion of aspiration of a foreign body. A leucocytosis may be present, adding still further credence to the theory of a simple pneumonia. Even the roentgen findings may be somewhat confusing, particularly if only one lobe is involved. The increased density of the lung in the roentgenogram, the dyspnea, the cyanosis, rapid pulse, leucocytosis, im-

paired resonance and abnormal breath sounds, all unite in shaping a diagnosis of pneumonia unless the possibility of foreign body atelectasis is borne in mind and its peculiar roentgenologic characteristics recognized.

In still another variety of case, the symptoms are cough with moderate fever. Physical examination of the chest fails to reveal any marked changes. Roentgen examination shows no opaque foreign body, and there is no pulmonary consolidation or atelectasis. In this type of case, the non-opaque foreign body produces incomplete bronchial obstruction, and a ball valve mechanism is set up in the partly obstructed bronchus, with fairly good ingress of air on inspiration, and poor egress on expiration. The roentgenological appearance is that of slight pulmonary congestion in the former instance, and emphysema in the latter. Manges is credited with the establishment of this valuable roentgenological sign.¹ It applies to intrabronchial tumors as well as to foreign bodies.

ROENTGENOLOGICAL SIGNS

The chief roentgenological signs following aspiration of a foreign body and its lodgment in a bronchus are of the three types mentioned above; (1) massive atelectasis, with retraction of the heart to the diseased side; (2) incomplete atelectasis, with a mottled shadow suggestive of bronchopneumonia, but usually on only one side, and (3) incomplete obstruction of the bronchus with demonstrable ball-valve action.

The characteristic picture of lung abscess may be found, as the presence of a foreign body, particularly of the vegetable type, favors development of pulmonary infection with subsequent abscess formation.

In those cases where the history is such as to lead the clinician to suspect unresolved pneumonia, the roentgen diagnosis may be extremely difficult, and unless the typical signs of atelectasis are present may be impossible.

Those unacquainted with the physical signs of atelectasis may suspect empyema. In differentiation, the chest wall is con-

This child had had a cold for three weeks, but a physician was not called until a "choking spell" occurred on the morning of February 21. Examination showed the nasal passages and throat clear, temperature normal, respiration rapid, finger nails and feet blue, and the child almost lifeless. By 11 A.M. respiration was more labored and rapid, temperature 102.5°F., and the left chest wall bulging, with the right somewhat flattened. The referring physician made

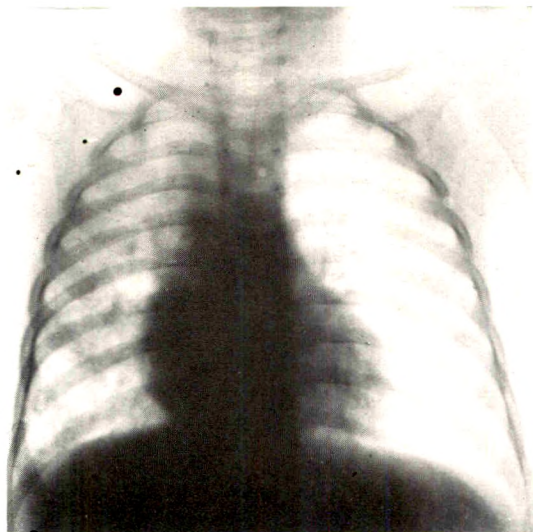


FIG. 1a. Case 1. February 21, 1931. Note congestion of right lung, retraction of heart to right, emphysema of left lung.

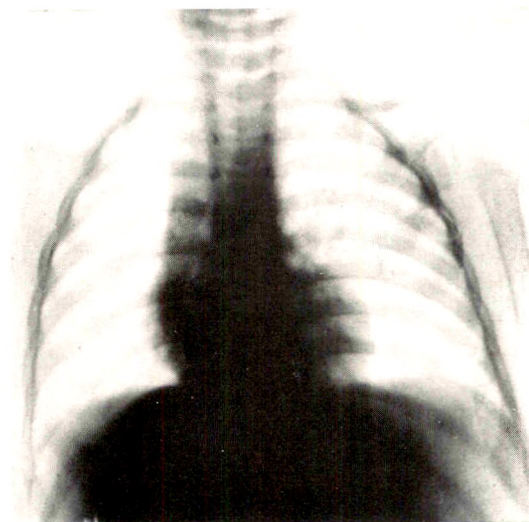


FIG. 1b. Case 1. March 2, 1931. Chest normal except for slight retraction of heart and trachea to right. Ten days after expulsion of mucous plug.

tracted in atelectasis, bulging in massive empyema; the heart is displaced to the diseased side in atelectasis, away from the diseased side in empyema; breath sounds are often diminished but seldom absent in atelectasis, they are more often absent in empyema. The contraction of the chest wall, the cardiac retraction, and the raised diaphragm in atelectasis should prove helpful roentgenological signs.

CASE REPORTS

The three following cases are presented because they illustrate the clinical and roentgenological findings commonly encountered after aspiration of a non-opaque foreign body.

CASE 1. White male, aged twenty months, referred by Dr. J. B. Collum, February 21, 1931.

a diagnosis of blockage of the right bronchus, probably by a foreign body.

At 12:30 P.M., at the time of the roentgen examination, the respiration was 40 per minute; there were dullness and increased pitch of breath sounds over the right upper chest posteriorly, and there were numerous râles throughout the right base and the left lung. The left chest was more resonant than the right. Cyanosis was marked. Roentgen examination showed moderate displacement of the heart to the right, elevation of the right diaphragm, and a mottled infiltration of the right lung. The left chest was emphysematous (see Fig. 1a). A tentative diagnosis of pneumonia was made, but bronchoscopy was advised if the child's condition improved sufficiently to permit the procedure being undertaken.

About three hours after the roentgen examination, the child coughed up a firm white mass "about the size of the end of the thumb." The

mother then pulled a mucous plug from the child's throat. Relief of the dyspnea was almost instantaneous, but the child was exhausted. The temperature subsided during the night. There were rhinitis and cough for several days but the rapid respiration, cyanosis and evident distress disappeared promptly after expulsion of the mucous plug. The parents did not determine what constituted the core of this plug, but they recalled that the child had eaten peanuts several days previously. Roentgen examination ten days later disclosed a normal chest (Fig. 1*b*).

Comment. This case represents a failure to make a correct roentgen diagnosis of bronchial obstruction by a non-opaque foreign body. In retrospect, the following points should have led to such a diagnosis: (1) the sudden choking attack; (2) the marked retraction of the heart to the side of the diseased lung. This does not occur in pneumonia to the extent noted in obstructive atelectasis; (3) the definite emphysema of the left chest, compensatory to the right atelectasis, and (4) the sudden onset of the dyspnea in a patient already ill for some time.

CASE II. White male, aged two and a half. Referred by Drs. Foster and Lunceford, Preston, Ga., December 8, 1930.

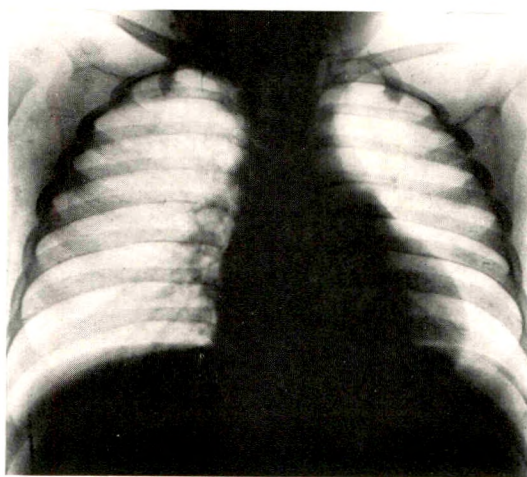


FIG. 2*a*. Case II. Ball valve action of foreign body in left bronchus. December 8, 1930. Inspiration. Diminished aeration of left lung, heart retracted to left, left intercostal spaces narrowed, left diaphragm raised.

One week previously the child was eating peanuts and had a "bad choking spell." Following this, there was a rather worrisome cough with slight elevation of temperature. A few

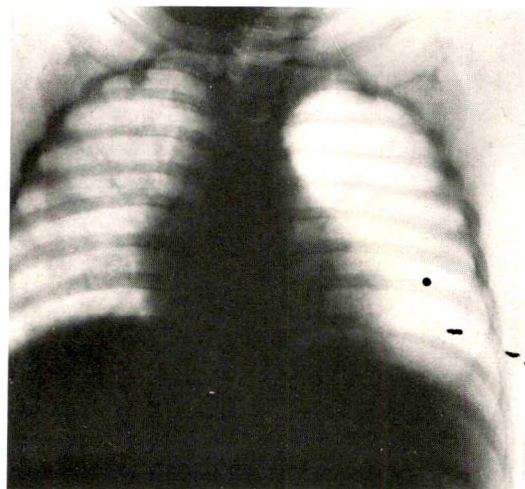


FIG. 2*b*. Case II. Expiration. Normal expiratory congestion of right lung, emphysema of left lung, heart returned to more normal position.

râles were heard in the left chest and breathing was harsh.

Roentgen examination. Pendulum movements of the mediastinum were noted roentgenoscopically. The inspiratory film showed retraction of the heart to the left, diminished aeration of the left lung, and contraction of the left intercostal spaces. The expiratory film showed displacement of the heart to the right, congestion of the right lung, emphysema of the left lung, and relative divergence of the left intercostal spaces. These findings were consistent with the "Manges sign" for ball valve obstructions of the bronchus. A diagnosis of non-opaque foreign body in the left bronchus was made, and bronchoscopy advised. On the following day, Dr. I. W. Irvin removed a peanut from the left stem bronchus. Recovery was uneventful (see Figs. 2*a* and 2*b*).

Comment. The valve action of a bronchial foreign body is well illustrated in this case. The dilated bronchus admitted air to the left lung on inspiration; the bronchus contracted around the peanut and trapped air in the left lung on expiration. It is often difficult, in small children, to obtain films at the desired stages of respiration, but

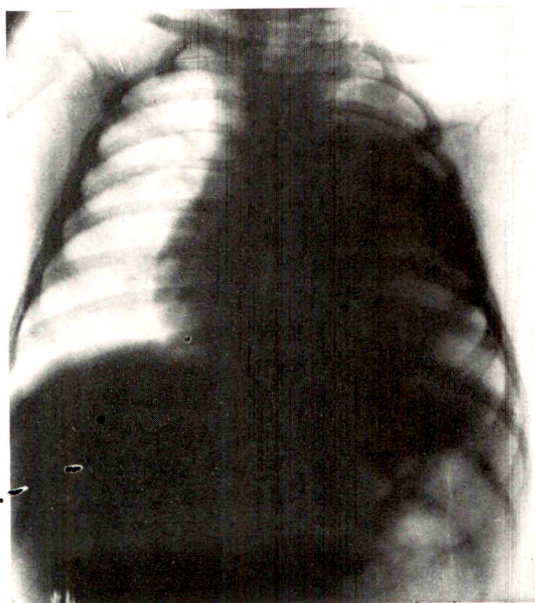


FIG. 3a. Case III. February 14, 1932. Obstructive atelectasis of left lung. Note contraction of left chest wall and partial aeration of apex and costophrenic angle.

the use of rapid technique and patience will usually yield satisfactory results.

CASE III. White female, aged one year, referred by Dr. W. E. Thomasson on February 14, 1932.

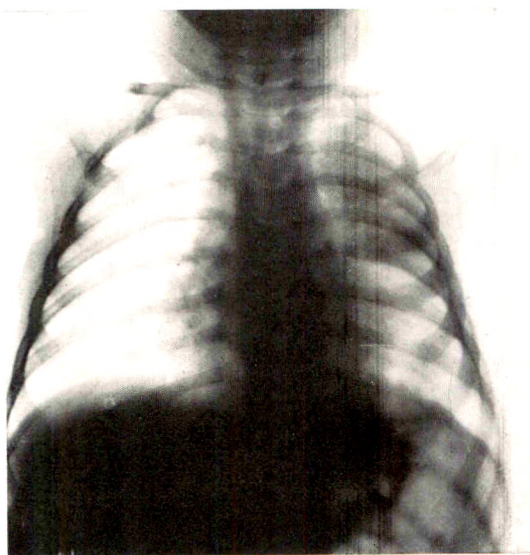


FIG. 3b. Case III. February 17, 1932, twenty-four hours after removal of paper from left bronchus. Note increased aeration of left lung.

For the past six weeks, the patient had had a cough and cold. The physical findings at no time definitely indicated pneumonia although there were dullness, decreased breath sounds, and increased voice pitch over the entire left lung. The left chest wall was flattened. These signs did not appreciably change during the five weeks the child was under observation. Temperature ranged from normal in the morning to 102°F. in the afternoon. Roentgen examination was repeatedly advised but refused by the parents until February 14, 1932, in the sixth week of illness. At this time the physical findings were as stated above, and it was noted that the child did not appear acutely ill.

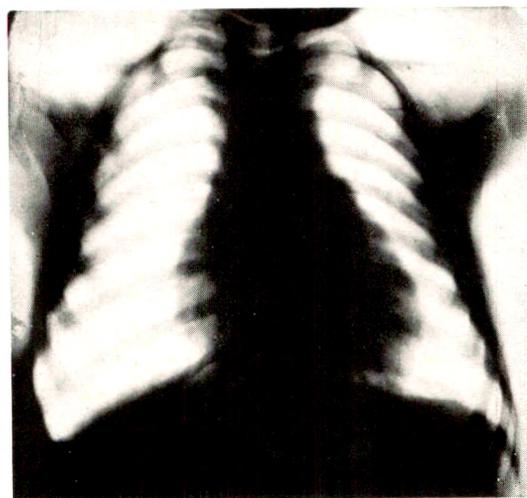


FIG. 3c. Case III. July 16, 1932, five months after removal of obstruction. Normal chest.

Roentgen examination showed almost complete atelectasis of the left lung, slight displacement of the heart to the left, elevation of the left diaphragm, and narrowing of the intercostal spaces. The roentgen diagnosis was stenosis of the left main bronchus, probably by a non-opaque foreign body, with resultant atelectasis of the left lung. This diagnosis was made despite the fact that no history of aspiration of a foreign body could be obtained even after careful questioning.

On February 16, 1932, Dr. I. W. Irvin removed at bronchoscopy a small piece of blue paper from the left bronchus. Roentgen examination on the following day revealed marked increase in the aeration of the left lung, and return of the heart to a more normal position (see Figs. 3a and 3b).

Roentgen examinations were again made on February 23 and March 5. There was still some atelectasis of the left upper lobe. Examination on July 16, 1932, revealed a normal chest (Fig. 3c).

Comment. The clinical findings and history in this case would lead one to suspect unresolved pneumonia, lung abscess or tuberculosis. The roentgen examination revealed an atelectasis, but bronchoscopy was necessary to determine the exact cause of the bronchial obstruction.

DISCUSSION

Among the conditions with which bronchial obstruction due to non-opaque foreign bodies may be clinically confused are: pneumonia, acute or unresolved; lung abscess; asthmatic obstructive atelectasis,² massive tuberculosis; atelectasis due to extrinsic pressure by enlarged tracheobronchial glands or tumors; intrabronchial tumors, benign or malignant; congenital bronchial stricture,² and laryngeal diphtheria. A roentgen study of suspected cases is always indicated, and often proves diagnostic, although even this diagnosis needs bronchoscopic confirmation. No case should be submitted to bronchoscopy without roentgenological examination, and the combination of the two procedures offers excel-

lent opportunity for medical teamwork.

The roentgenological examination should consist of roentgenoscopy and of films made in inspiration and expiration. Lateral views of the thorax are of value in determining what lobes are involved.

Bronchography with iodized oil would demonstrate bronchial obstruction but its application in children, in whom the majority of the cases of foreign body aspiration occur, is often difficult. If this procedure is employed in a child in a suspected case of bronchial occlusion by a foreign body, the transcricoid route should be used, as attempts to introduce oil between the vocal cords by means of a catheter might so traumatize the cords as to produce edema, a condition unfavorable to the eventual bronchoscopy which must be done to remove the foreign body.

The possible presence of a foreign body in the tracheobronchial tree should always be borne in mind in considering pulmonary disease in children.

REFERENCES

1. MANGES, W. F. Quoted by Sante, L. R. In: *The Chest Roentgenologically Considered. Annals of Roentgenology*. Vol. XI. Paul B. Hoeber, New York, 1930.
2. TUCKER, GABRIEL. Bronchoscopic observations on obstructive pulmonary atelectasis. *Arch. Otolaryng.*, 1931, 13, 315-325.



AN UNUSUAL ROENTGENOLOGIC FINDING IN MULTIPLE MYELOMA*

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THE bone marrow is a highly important source of destructive tumors, and it is "probable that specific diseases result from the overgrowth of each particular cell composing this tissue" (Ewing²).



FIG. 1. Photograph showing subcutaneous nodules.

Thus, broadly speaking, any primary tumor of bone, which contains the blood-forming cells can be classified as multiple myeloma. This viewpoint may help clarify the present conception that multiple myeloma is a definite clinical entity.

We believe that the following case is of interest, both from a clinical and a roentgenologic standpoint:

CASE REPORT

H.S., white female, married, aged twenty-two, was admitted to the medical service of the University Hospital on the service of Dr. C. W. Baldrige on December 5, 1930. Patient was five months pregnant, and well, up to May 31, 1930, at which time she began to develop a steady pressure-like pain in the sacrum. A premature delivery in June, 1930, was done in an effort to give patient relief from the pain. Relief

was obtained, although the fetus died. For two weeks post partum she had an unexplained fever. She also noticed that she bled more easily and lost more blood at this delivery than at previous deliveries. In July, 1930, patient had "rheumatism" involving ankles, knees, elbows, and wrists. She had no fever at this time, nor did the affected joints become red or swollen. In September, 1930, patient first noticed some small, papular, very hard skin lesions on her face and neck. These skin lesions have gradually spread over her body. She has noticed some slightly enlarged glands in her neck for an indefinite period. She thought she had lost weight.

Family and past history not essential. She has one child living and well. Examination at entrance revealed whitish, hard, shotty papules about 5 mm. in diameter, apparently subcutaneous and generalized, except over upper trunk and back. These felt like the lesions of smallpox, and were not tender. The elbow, wrist, and finger joints were swollen, stiff, and tender. These joints were tender on motion but were not hot or reddened. A peculiar feature was that patient stated that the skin nodules would come and go. Cervical, axillary, and inguinal glands were palpable. The left lobe of the liver was three finger breadths below the costal border.

Laboratory Data. Hemoglobin varied from 33 to 39 per cent; red blood cells from 2,000,000 to 2,375,000; and white blood cells from 6,800 to 11,600. The typical differential count was—myelocytes, 22 per cent; basket cells, 21 per cent; lymphocytes, 14 per cent; unclassified cells, 13 per cent; band polymorphonuclears, 6 per cent; metamyelocytes, 7 per cent; basophilic myelocytes, 1 per cent, Turck's irritation cells, 1 per cent; eosinophiles, 3 per cent; basophiles, 1 per cent. Nucleated red cells with variation in size and shape of the red cells were found. Blood Wassermann negative. Coagulation time was five minutes, with bleeding time fifteen minutes. Arm band test for petechiae strongly positive. There were 10 per cent reticulocytes. Blood calcium was 11 mg. and blood phosphorus 4.0 mg. Blood cholesterol was

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192.3. Basal metabolic rate varied from +64 to +70. Urine negative for Bence-Jones protein. A biopsy of a lymph gland from one groin and a section of skin were reported as metastatic carcinoma.

She was given roentgen therapy to a small area about 8×10 cm. over the anterior right thigh with the following factors: 4 ma.; 140 kv.; 50 cm. distance; 3 mm. Al as filter, and 200 r as a dose, once. The subcutaneous nodules were gone in forty-eight hours from the treated areas.

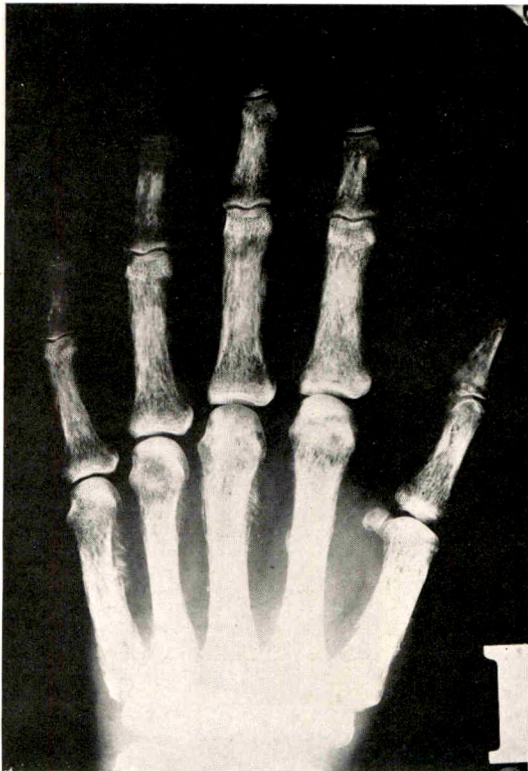


FIG. 2. Roentgenogram of right hand.

The posterior aspect of the left elbow joint was next treated with the same technique and the same result. We were convinced, following these results, that we were dealing with a very cellular growth, probably primary in the bone marrow.

The course of the patient was progressively worse, and she died about December 30, 1931, at home. A post mortem was performed and the organs sent to University Hospital.

DISCUSSION

The roentgenological findings were extremely interesting. Not only were there

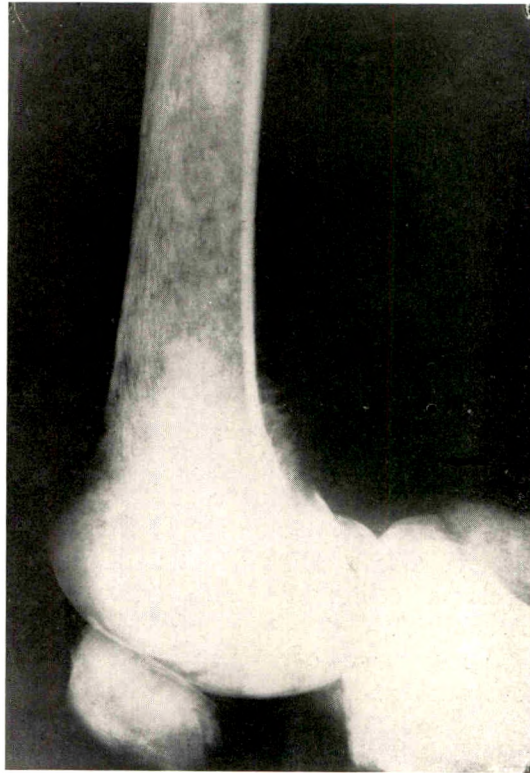


FIG. 3. Lateral roentgenogram of right femur. The "whiskers" and areas of destruction are readily seen.

multiple areas of destruction but there were also attempts at new bone formation, as could be seen by the "whiskers" of bone which were laid down perpendicular to the bones. Similar perpendicular striations

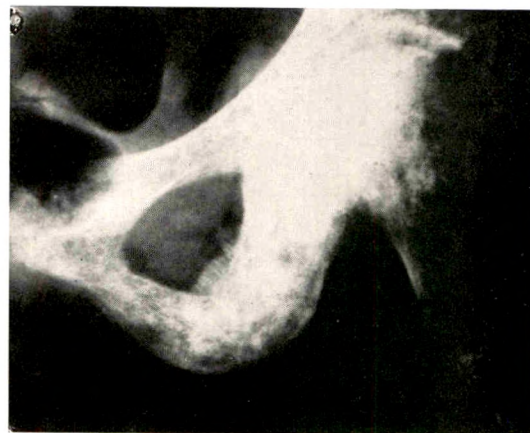


FIG. 4. Anteroposterior roentgenogram of left hip—a contact reproduction.

of bone are seen in osteogenic sarcoma (Ewing). Vogt and Diamond⁷ report a similar condition in sickle cell anemia, and state, "The cortex becomes thin and there is occasionally an area that appears to be punched out, due to localized invasion by marrow substance." However, blood examination readily ruled out sickle cell anemia, and also no cases of sickle anemia have been reported in adults. Meyerding⁶ suggests the possibility of multiple myeloma causing such reaction as he states, "Later they perforate into the periosteal structures, giving a punched-out appearance, or a honeycomb appearance to the bone, due to the shadow cast from remaining particles of bone on the surface of the tumor." Also, Morse⁵ adds "that the myeloma cell may be a heteroplastic 'osteoblast'."

The absence of Bence-Jones protein does not rule out multiple myeloma (Ew-

ing,² Geschickter and Copeland³), nor does its presence absolutely confirm it (Boggs and Guthrie,¹ Hansen,⁴ Geschickter and Copeland,³ Wood and Lucke⁸).

We have seen similar attempts at healing in both luetic and ordinary osteomyelitis, when only one bone was involved. The generalized involvement made us diagnose the condition as probably a primary medullary bone malignancy.

The pathologic diagnosis was myeloblastoma, the predominating cell being the myelocyte.

SUMMARY

The term multiple myeloma includes any primary bone tumor which contains the blood-forming cells.

A case is here reported, which shows a generalized attempt at healing of a primary bone tumor, ordinarily mentioned as multiple myeloma.

REFERENCES

1. BOGGS, T. R., and GUTHRIE, C. G. The Bence-Jones proteinuria in conditions other than myelomatosis. *Johns Hopkins Hosp. Bull.*, 1912, 23, 353-356.
2. EWING, JAMES. Neoplastic Diseases. Third edition. W. B. Saunders and Co., Philadelphia, 1931.
3. GESCHICKTER, C. F., and COPELAND, M. M. Multiple myeloma. *Arch. Surg.*, 1928, 16, 807-863.
4. HANSEN, O. S. Multiple myeloma. *J. Am. M. Ass.*, 1922, 79, 2059-2061.
5. MORSE, P. F. The peroxidase reaction in three cases of multiple myeloma of the bones; with remarks concerning the nosological position of these tumors. *J. Cancer Research*, 1920, 5, 345.
6. MEYERDING, H. W. Multiple myeloma. *Radiology*, 1925, 5, 132-146.
7. VOGT, E. C., and DIAMOND, L. K. Congenital anemias, roentgenologically considered. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1930, 23, 625-630.
8. WOOD, A. C., and LUCKE, B. Multiple myeloma of the plasma-cell type. *Ann. Surg.*, 1923, 78, 14-25.



or the later development of gland metastases was used as an index of the metastasizing power of the growth.

Table XIV shows a definite increase in the percentage of metastases in the glands as the tumor shows a less differentiated appearance in the microscope. It would be very easy to go on from here and state that at least a large part of our improved results was due to paying attention to this aspect of our cases. Unfortunately, it is not so simple. The reason it is not so simple is that most of the Grade 1 pathological reports occur on the cases that are among the smallest, and vice versa. Therefore these cases are more favorable for their small size as well as their appearance of slow growth. Table XV differentiates these same cases according to grade and size.

The first thing to note is that almost half the cases occur in one box, that of the lowest grade and smallest size. Another quarter of the cases are in the adjacent

divided into the same boxes, but also includes data on the duration of symptoms up to the time of treatment. The duration is expressed in weeks of the median cases of the group. Note that in the Grade 1

TABLE XIV

PRIMARY, SMALL OR NO GLANDS

All Operations Divided by Pathological Grades, Presence or Development of Gland Metastases

Grade	Cases	Glands Positive Per Cent
1	49	10
2	20	20
3	7	43
Total	76	16

cases the duration of those not metastasizing is about half that of those that did so; that similar results occur in Grade 2. But with Grade 3, or the highest degree of malignancy, the duration of the cases not metastasizing was greater than that of those that did, and also was as great as that

TABLE XV

PRIMARY, SMALL OR NO GLANDS. ALL OPERATIONS DIVIDED BY PATHOLOGICAL GRADES AND SIZE OF TUMORS. PRESENCE OR DEVELOPMENT OF GLAND METASTASIS

Grade	0-1 cm.		1.1-2.0 cm.		2.1 cm. +		Total	
	Cases	Glands + Per cent	Cases	Glands + Per cent	Cases	Glands + Per cent	Cases	Glands + Per cent
1	32	6	13	15	4	25	49	10
2	9	11	7	14	4	50	20	20
3	1	0	2	50	4	50	7	43
Total	42	7	22	18	12	42	76	16

boxes of smallest size with medium grade and of smallest grade with medium size. The distribution of the rest of the cases spreads them so thin that the groups are not of great statistical value. However, if one glances down each column, one sees the results in cases of the same size as we progress to cases of higher malignancy. It is perfectly obvious, then, that there is here no statistical proof that higher degrees of malignancy cause higher liability to metastasis in cases of comparable size, as we have just mentioned.

Table XVI shows exactly the same cases

in the metastasizing Grade 1 cases. Among the large and also among the Grade 3 cases, as well as among those in both classifications, there must be comparatively slowly growing tumors which do not metastasize early.

Hardly a cursory examination of the literature on the grading of cancer of the lip has been made since demonstrating the statistical effect of the relationship of size of tumor to the results of treatment according to grade, but except for a single sentence in Broders' original paper we know of no consideration of this possibility. Broders,

however, did mention the fact that there were proportionately more large tumors in his Grade 3 group than in his lower grades. He used four grades but put only 1 per cent of his cases in Grade 4, which was his least differentiated group.

should be of comparatively short duration.

2. We believe the best local treatment of small lesions to be an adequate surgical excision, but would also approve adequate radiation treatment following a biopsy. By adequate irradiation we mean doses of

TABLE XVI

PRIMARY—SMALL GLANDS. ALL OPERATIONS DIVIDED BY PATHOLOGICAL GRADE AND SIZE OF TUMOR. DURATION IN WEEKS BEFORE OPERATION—PRESENCE OR DEVELOPMENT OF GLAND METASTASES

		0-1 cm.		1.1-2.0 cm.		2.1 cm. +		Total	
		Cases	Duration Weeks	Cases	Duration Weeks	Cases	Duration Weeks	Cases	Duration Weeks
Grade 1	No metastases	30	20	11	32	3	20	44	20
	Metastases	2	46	2	32	1	78	5	46
Grade 2	No metastases	8	15	6	20	2	103	16	20
	Metastases	1	78	1	46	2	26	4	39
Grade 3	No metastases	1	46	1	20	2	128	4	46
	Metastases	—	—	1	20	2	39	3	32
Total	No metastases	39	20	18	26	7	78	64	25
	Metastases	3	46	4	32	5	32	12	38

It must not be inferred that we claim that grading of a tumor is unimportant or useless. We only point out that the tables that have correlated grading to prognosis have possibly been so striking because of the distribution of a preponderantly large number of small, easily curable tumors in Grade 1, as was certainly true in this group of cases.

SUMMARY AND CONCLUSIONS

As a result of this study, certain definite broad rules for the management of patients with this disease may be laid down.

There is no justification for not considering the pathological grading of a tumor as an important aid in deciding on treatment, but perhaps it should not be stressed as strongly as size and duration.

1. Small lesions, without deep ulceration, infiltration or enlargement of the glands of the neck may be safely treated by local treatment only. These cases should all be of Grade 1 pathology and

from 500-1000 mc-hr. of radium with considerable filtration for small lesions, and larger doses in larger lesions.

3. All other patients up to the limits of reasonably safe operability should have submaxillary and submental neck dissections, whether the local lesion is treated with radium or surgery.

4. Although there is nothing in this paper on the subject, we believe that most patients who have had neck dissections should have at least 900 r of high voltage roentgen therapy to each side of the neck, and that this should be repeated if the glands in the neck are positive for carcinoma.

5. Patients with fixed, deep, or large masses in the neck should be treated by radiation for palliation only.

6. Every case must be decided individually and some must be given less than the optimum treatment for reasons of age, other diseases, or poor general condition.*

* For discussion see page 88.

FIVE-YEAR END-RESULTS OBTAINED BY RADIATION TREATMENT OF CANCER OF THE LIP*

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IN THE past, cancer of the lip was a purely surgical disease. Since the advent of roentgen rays and radium continuous effort on the part of the radiologist has gradually raised the question of which form of treatment is the most efficacious, or whether a combination of the two should be used. If the question were asked of this audience, I venture to say opinion would be divided, each feeling that his method of treatment is the best.

The surgeon urges patients to come early when lesions are small and favorable for excision and dissection of the neck glands, well knowing that the results become poor as soon as metastases are shown in the nodes. Cases past this stage have little appeal to him in a curative way. On the other hand, the radiologist will often presume to treat all types of lip cases, generally after they have been the rounds of various medical advisers, and he probably more often gets the majority of advanced lesions, including the inoperable as well as the recurrent cases, often referred by the surgeon. The surgeon, hoping he can circumscribe all the cancer cells with his knife, cuts far and wide leaving what the cosmetic-minded radiologist insists are ugly deformities. The radiologist treats the lesions with roentgen rays and radium which he trusts will kill the cancer cells, subjecting, as the surgeons say, his patient to future metastases. Here, most properly, steps in the combinationist, the surgeon-radiologist. To him comes the more momentous problem, that of the best method of treatment in combating metastatic lymph nodes, the problem which both the radiologist and the surgeon equally dislike, well knowing that the results are unsatisfactory.

When one consults the literature on this subject the same indecision is apparent. Numerous surgical statistics have been published, but as many lack detail one cannot make a fair appraisal of the merits of pure surgical procedure; for example, Bloodgood¹ states that where the lesions are small and there are no demonstrable enlargements of the lymph nodes, 100 per cent are alive and well after five years, and that about 50 per cent of those showing metastases are well after five years. He does not give any figures on large or extensive lesions of the lip. Fischel² reports that 88 per cent of those not showing metastatic nodes are alive and well five years but does not state what percentage of those that have metastases in the lymph nodes are well. Shedden,⁴ reporting three-year results for the American College of Surgeons, gives 76 and 42 per cent in the first two groups respectively. Brewer³ in 1923 compiled surgical statistics which included those of Bloodgood, Beckman, Sistrunk, and his own, and gives 66 per cent well five years after local excision; 92 per cent well five years after radical operation, performed where no metastases were demonstrable; and 34 per cent in cases showing definite metastatic involvement of the nodes.

In this study of the surgical literature some very pertinent questions present themselves: (1) the size of the lesion; (2) its location, whether near the corner of the mouth or at the midline; (3) the duration of the lesion prior to admission; (4) the absolutely known fact that not all enlarged nodes are metastatic and that in a considerable number of cases where no nodes are palpable, metastases subsequently develop. These questions in diagnosis are important in evaluating methods of treatment.

* From the State Institute for the Study of Malignant Disease, Buffalo, N. Y. (Burton T. Simpson, M.D., Director). Read in a Symposium on Cancer of the Lip, Seventeenth Annual Meeting, American Radium Society, New Orleans, La., May 9-10, 1932.



FIG. 1. Small lesion without palpable nodes, before treatment. Group 1 case.



FIG. 2. Same case as Figure 1 after treatment, now well over five years.

• The radiologist and surgeon present statistical figures attempting to prove their contention and display enthusiasm for their particular methods, but the truly scientific mind is still in doubt because these figures, when carefully scrutinized, are generally based on too few cases and commonly entail a variety of classifications; that is, based on three- or five-year arrests, on large or small primary lesions, without glands palpable, etc., so that, when all statistics are considered as a whole, very little unity can be derived from them. What is first needed is a satisfactory classification to suit, if possible, the surgeon and the radiologist, so that both may speak a common language. Without this, little can be gained by discussion.

Instead of there being antagonism between the surgeon and radiologist, let all meet on some common ground to establish what is the best procedure for the good of the patient.

With these preliminary facts, we wish to present the results of our analysis of 285 cases treated at the State Institute for the Study of Malignant Disease. All of these cases were treated between 1914 and 1927, during which time the technique of irradiation was undergoing an almost continuous change. Nevertheless in evaluating the results this factor is not stressed and the effort here is to make, if possible, a comparison with the surgical statistics.

It was plain to the workers at the Institute that in order to arrive at any definite conclusions a systematic study with a carefully planned piece of work was necessary. Accordingly, our tumors of the lip were divided into three anatomical groups. In Group 1 were placed all lesions on the lip, no matter how small or how extensive, but with no palpable nodes in the lymphatic drainage areas. Many cases, impossible to deal with surgically except by very wide excision and plastic operation,

fell into this group, making it difficult to compare our results with surgical statistics. In Group II, any size lesion on the lip with definite enlargement of the lymph nodes on one or both sides of the neck which were movable and apparently so-called opera-

the local lesion, an estimated value of two to four times the erythema dose, 140,000 peak voltage, 10 milliamperes, no filter, time from 3 to 9 minutes, at a distance of 20 to 22 cm.⁶ Radium treatment consisted of large amounts of radium filtered through

TABLE I
RESULTS OF TREATMENT OF 163 GROUP I CASES—NO ENLARGEMENT OF NODES IN NECK

	Treatment to Local Lesion Only—131 Cases		Treatment to Local Lesion and Surrounding Lymph-Bearing Areas—Prophylactically—32 Cases	
	Lesions 1.5 cm. or less; 70 cases 98.5 per cent primary healings	Lesions over 1.5 cm.; 61 cases 91 per cent primary healings	Lesions 1.5 cm. or less; 12 cases 100 per cent primary healings	Lesions over 1.5 cm.; 20 cases 95 per cent primary healings
Five-year healings Relative Absolute	40 cases—85% —57%	21 cases—58% —34%	6 cases—86% —50%	10 cases—59% —50%
Died of cancer Primary healings Recurrence primary lesion	3 cases 2 cases	13 cases 8 cases 4 cases	1 case 1 case	6 cases 5 cases 5 cases
Living over five years, now well, but not continuously well for five years	4 cases	2 cases		1 case
Died from intercurrent disease*	17 cases—all well at time of death	9 cases—all well at time of death	3 cases—2 well at at time of death, 1 had recurrence	1 case—well at at time of death
Lost trace of*	6 cases 3 clinically well 3 undetermined	16 cases 11 clinically well 4 undetermined	2 cases Both clinically well	2 cases Both clinically well
Developed enlarged nodes	9 cases	17 cases	1 case	7 cases
Nodes disappeared under treatment	6 cases	4 cases		1 case

* Cases lost trace of and those who died from intercurrent disease are not considered in estimating the relative five-year healings.

ble; in Group III, cases recurring after operation with metastases in the neck which were fixed; or untreated cases with extensive involvement of the lip, periosteum of the jaw, or fixed lymphatic involvement.

The technique of the treatment given was as follows: Unfiltered roentgen rays to

0.1 mm. brass, held in position for from 15 to 16 mc-hr.; the application of radium tubes for 200 to 250 mc-hr. per tube, filtered through 2 mm. brass, 1 mm. rubber; or the implantation of glass seeds of 1.0 or 0.8 mc. of radon. High voltage roentgen treatment to the neck, and in a few instances covering the lip tumor, consisted of



FIG. 3. Large lesion without palpable nodes, before treatment. Group 1 case.



FIG. 4. Same case as Figure 3 after treatment, now well over five years.

•200,000 volts, 8 milliamperes, filter 0.5 mm. copper and 1 mm. aluminum, distance 30 to 50 cm., time varying as to the distance used. Factors for the filtered low power roentgen radiation were: 140,000 peak voltage, 5 milliamperes, 3 mm. aluminum filter, time from 8 to 10 minutes, at a distance of 25 cm.

One hundred and sixty-three cases were placed in Group 1 (see Table 1).

One hundred and thirty-one cases were treated locally only with unfiltered roentgen rays or radium. Seventy of these were small lesions of 1.5 cm. or less; 61 were large lesions measuring over 1.5 cm.

Of the 70 small lesions, 40 have been well five years or more after treatment. This group shows 85 per cent relative five-year healings and 57 per cent absolute five-year healings. Three died from metastases; in 2 the lip had been well, one for four years and one for one year; in the other case the lip never healed. Four are living over five

years, are now well, but have not been continuously well for five years. Seventeen died from intercurrent disease; all were free from any evidence of malignancy; 4 for over four years, 5 for over three years, 3 for over two years, 2 for over a year, and 3 for less than a year. Six were lost trace of, 3 were clinically well for from less than a year to over two years, 3 did not return after treatment so the result was undetermined. Nine in this group developed enlarged nodes which we thought might be metastatic, in only 3 cases did the nodes progress causing death, in the other cases they disappeared following treatment. Primary healing was achieved in 98.5 per cent of these cases.

Of the 61 large lesions, 21 have been clinically well five years or over. This group shows 58 per cent relative five-year healings and 34 per cent absolute five-year healings. Thirteen died from metastases, in 4 the lip was well at the time of death, in 4

shop, with a great many other activities. We have printing, show card writing, looms, flower making and several other items. The injured workers start in at seated occupations, using an ordinary coping saw, cutting out stencils, the lightest sort of occupation that any individual can do if he has the use of his hands and is able to get to a place. We arbitrarily appraise a disability of an individual in accordance with the type of work that he can do. If he is only able to go to this first process and not go on to the second or third process, we consider his disability two-thirds of the total. We feel if he can do this, he has, at least, one-third functional vocational capacity.

The next mechanical process is a little more difficult. The man has to stand at a work bench and use a file, hammer and saw, work which varies from light to moderately heavy operations. We call this standard practice.

And, finally, he has to do the third type of work, the hardest kind of carpentry, climbing up and down ladders, and using a hammer, saw, nails and file—on the heaviest kind of work projects.

Regardless of the part of the body involved, physiological utility can be used as a measure of disability. For example, function in the upper extremity is expressed in the factors of motion, strength and coordination which can be measured. Weight bearing is the chief physiological function of the lower extremity. In endocrine disturbances like diabetes it is the carbohydrate metabolism that forms the functional basis for the determination of permanent disability. In nephrectomy it is the remaining kidney function which is

utilized as a basis for determining the compensation that is to be paid.

The structural changes resulting from accidental injuries show no consistent or direct correlation with the functional disability.

A severe fracture deformity may be accompanied by little or no functional disability; while a minor structural change may occasion a severe functional disability. This is due to the fact that the body economy contains a safety factor in the presence of disease. The body must maintain its normal function or it dies. It continues to operate by having extra resources to call upon both in structure and function. Through self-repair, regeneration, hypertrophy dependent on new conditions, vicariousness of function, the body combats its environment.

The end-results of industrial accidents, therefore, should be appraised not on the basis of structural changes but on disturbed function.

The conservation and protection of our man power depends on the concept of the worker as a social and economic unit. Because of the accident hazards of industry, it is necessary to preserve this man power by proper health and accident safeguards. Where safeguards are inadequate and injury occurs replacements for reduced earning capacity should be made in the form of *compensation* awarded on a rational basis. Where compensation is inadequate to re-establish the worker as an independent economic unit, he should be rehabilitated and restored to remunerative employment through physical and vocational re-training.*

* For discussion see page 49.



TRAUMATIC NEUROSIS*

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THE term traumatic neurosis has been a most abused term during the past few years for it has been used indiscriminately to cover all conditions following injury that cannot be accounted for on an organic basis. The term itself is a poor one, especially in industrial medicine or in the legal phase of medicine because the word traumatic immediately causes prejudice. Some authorities have suggested the use of the diagnosis "neurosis following injury" in cases of so-called traumatic neurosis until it has been definitely decided whether or not the neurosis is the result of the injury or whether it merely appeared after the accident without having any relationship. This, I believe, is a much preferred diagnostic term.

- We are all aware of the increase in the frequency of neuroses associated with injury. This is due to a number of factors. The most important of these are lack of employment, the ever increasing speed of factory work with a resultant driving of employees, fear of losing position, and avarice that later changes from malingering to a true neurosis.

To arrive at a diagnosis of neurosis following injury should offer no great difficulty if we adhere strictly to the definite signs of a neurosis. It is not just to say that any complaint a patient has and cannot be accounted for on an organic basis is a neurosis. Such a practice encourages malingering and also makes it difficult for the person with a true traumatic neurosis to obtain what is due him. The signs of a neurosis following injury are emotional instability, such as weeping attacks and depression, vasomotor disturbances such as flushing and dermatographia, increased tendon reflexes, fine tremor of the hands, increased electrical excitability of the skeletal muscles, trophic changes, fast thready pulse

and an attitude of despair. I do not mean to give the impression that all of these signs are necessary for a diagnosis but a sufficient number should be present to exclude any element of doubt.

Of course, the best way to combat the increasing incidence of neurosis associated with injury in employment is to attack it from the preventive side. Industry, itself, can be of great help in this without a great deal of effort. The employer should take an accurate employment history of a prospective employee before he is hired to determine whether or not he is fit to do factory work. The worker who changes his place of occupation frequently and the nature of his work frequently without advance is not the desirable kind. The employee who does this usually finds it difficult to adjust himself to any fixed environment and is very prone to develop a neurosis at the slightest provocation. The examining physician should also note whether or not there is any evidence of emotional instability and also if the prospective employee is hypersuggestible. The employer should make every effort to give the employee a pleasant environment in which to work which is most easily obtained by having foremen who do not constantly antagonize the men below him. The medical attendants, especially the first aid men, must be careful what is said in the presence of the injured immediately after an accident because during this period fear is quite marked and remarks such as, "If it had struck him one inch further down he would have been a goner," have their effect. During any emotional reaction one is unusually suggestible.

After the diagnosis of a neurosis has been made, the next step is to determine whether or not the neurosis is related to the injury. This necessitates observation of the

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

the lip healed after treatment but recurred, in 5 the lip never healed. Two are living over five years, are now well, but have not been continuously well for five years. Nine died from intercurrent disease, all were well at the time of death, 2 for over three years, 3 for over a year, 4 for less than a year. Sixteen were lost trace of, in 11 the lesion was well, 1 for four years, 3 for over three years, 3 for over two years, 2 for over one year, 2 for less than a year; 4 were undetermined as they did not return after the first treatment; in one case the primary lesion was healed but the metastases which had developed were progressing. Seventeen in this group developed enlarged nodes which we thought might be metastatic; in 13 cases the nodes progressed causing death, the other 4 disappeared with treatment. Primary healing was achieved in 56 cases, or 91 per cent.

Thirty-two cases were treated over the

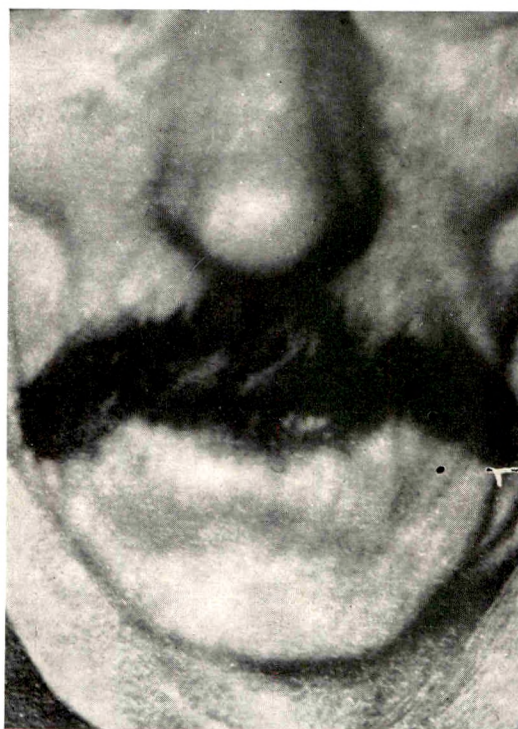


FIG. 6. Same case as Figure 5, after treatment, now well over five years.

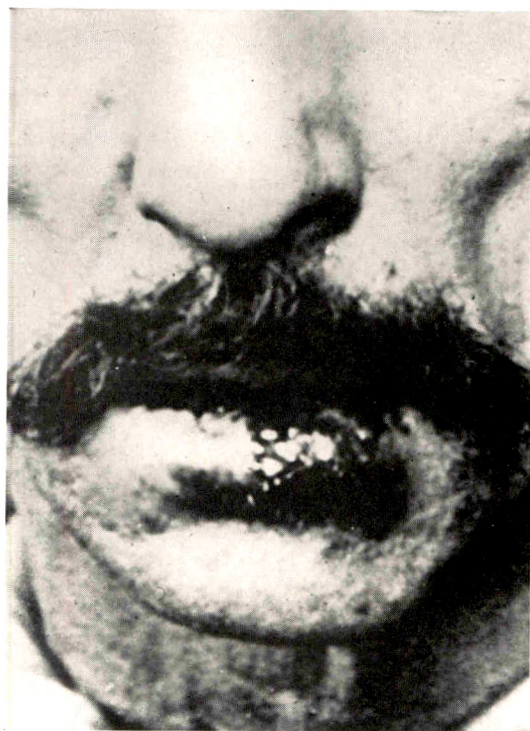


FIG. 5. Large lesion on lip with palpable nodes in left submental and submaxillary regions, before treatment. Group II case.

surrounding lymph-bearing areas as well as locally. Twelve of these were small lesions of 1.5 cm. or less; 20 were large lesions measuring over 1.5 cm.

Of the 12 small lesions, 6 have been clinically well five years or over; 86 per cent relative five-year healings, 50 per cent absolute five-year healings. One died from metastases five years after admission, the lip remained well from the time of first treatment. Three died from intercurrent disease, 2 had been well for over three years, one was clinically well for one year when he had a recurrence and shot himself. Two were lost trace of in less than a year, both lesions were well. Only one in this group developed metastases; 100 per cent showed primary healing.

Of the 20 large lesions, 10 have been clinically well five years or over; 59 per cent relative five-year healings, 50 per cent absolute five-year healings. Six died from metastases, in 5 the lip healed but the le-

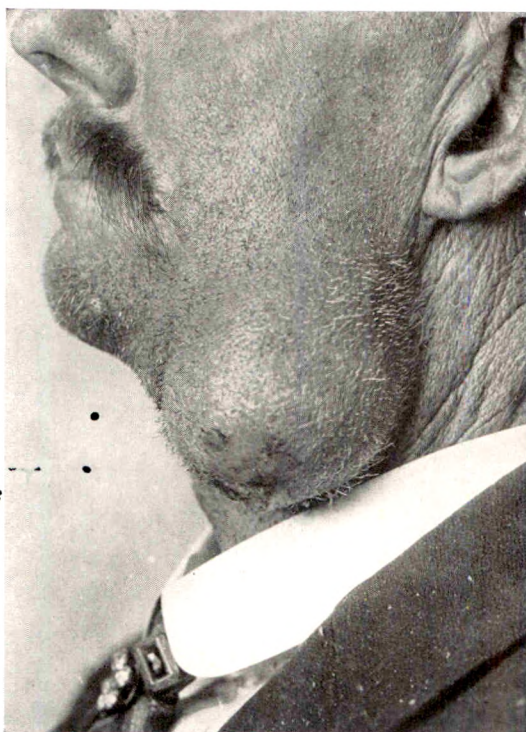


FIG. 7. Large submaxillary metastasis.

sion recurred before death; in one the lip never healed. One is living eleven years from the time of admission, is now well, but has not been well for five continuous years. One died from intercurrent disease after being well for four years and ten months. Two were lost trace of, both were clinically well. Seven in this group developed enlarged nodes which we thought might be metastatic, in 6 cases the nodes progressed causing death, in one case the nodes disappeared after treatment.

Of the 163 cases treated in Group 1, 77 are clinically well five years or longer, or 47 per cent absolute five-year healings; 107 are available for five-year statistics, of which 77, or 71.9 per cent, are relative five-year healings. Of the 157 cases which were followed at least once after treatment, 150, or 95 per cent, had primary healings. Nine of this 150, or 5.7 per cent of the total, recurred without subsequent healing.

Twenty-six of the cases (19.8 per cent) which were treated locally only, developed

enlarged nodes. Eight of the cases (25 per cent) which were treated over the lymph-bearing areas, as well as locally, developed enlarged nodes.

Thirty-eight cases were placed in Group II (see Table II). Eight cases are clinically well for five years or longer, 29.6 per cent relative five-year healings, 21 per cent absolute five-year healings. Eighteen cases died from the disease, in 8 the lip was healed at the time of death, in one the lip healed but recurred before death. Six of these cases died between one and two years; 3, from two to three years; 2, from three to four years (1 of these cases was clinically well two years seven months when there was a recurrence on the lip and metastases); one, from four to five years; one, from five to six years, was clinically well four years ten months when there was a recurrence of the metastases, the lip remained well at the time of death. One case is living over five years, is now well but has

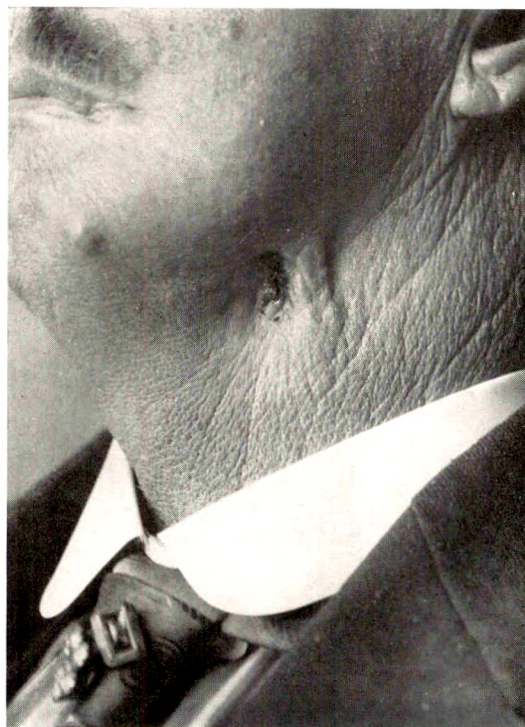


FIG. 8. Same case as Figure 7, nine months after treatment by high power roentgen rays.

not been continuously well for five years. Four cases died from intercurrent disease, 3 were clinically well from one to three years; one died in a month, the lesion had improved. Seven cases were lost trace of, one had been clinically well for six months,

13 were recurrent after local excision and dissection of the neck glands. In 25 of these cases the lip remained well at the time of admission but the metastases were hard and fixed. Only one of the 79 cases treated in Group III, or 1.2 per cent, is well for over

TABLE II
RESULTS OF TREATMENT OF 38 GROUP II CASES

Five-year healings Relative Absolute	Lesions larger than 1.5 cm.—Nodes palpable on one or both sides of the neck—27 cases	Lesions 1.5 cm. or less—Nodes palpable on one or both sides of the neck—11 cases
	6 cases—31% —22%	2 cases—25% —18%
Died from cancer	13 cases 1 clinically well 4 yr. 10 mo., recurrence of metastases, lip remained well; 1 clinically well 2 yr. 7 mo., recurrence on lip and metastases; 5 in from 1 to 4 years, lip remained well at time of death in 4 cases; 6 died in less than a year, unimproved	5 cases 1 clinically well 1 yr. 10 mo., recurrence of metastases, lip remained well; 4 died in from 1 to 3 years, in 2 cases the lip remained well at the time of death
Living over five years, now well, but not continuously well for five years		1 case
Died from intercurrent disease*	4 cases 3 clinically well for from 1 to 3 years; 1 unimproved—1 month	
Lost trace of*	4 cases 1 clinically well 6 months; 1 lip healed for 4 months, metastases remained the same; 2 undetermined—did not return after treatment	3 cases all in less than a year, lip healed in 2 cases

* Cases lost trace of and those who died from intercurrent disease are deducted from the total number of cases in estimating the relative five-year cures.

in 3 the lip was healed but the metastases remained the same, one case was unimproved, 2 were undetermined as they did not return after first treatment.

Primary healing was achieved in 25 cases, or 65 per cent, of the Group II cases.

Eighty cases were placed in Group III, 21 of these were recurrent after local excision,

five years (absolute statistics). Discounting the lesions which were healed at admission, 11 of 54, or 20 per cent, showed primary healing, 2, or 18 per cent, of those healed, recurred.

CONCLUSIONS

1. This study includes cases treated between 1914 and 1927, and is based on

285 cases which were arranged in three groups according to the amount of anatomical involvement.

TABLE III
FIVE-YEAR RESULTS—EPIDERMOID LIP CARCINOMA

	No. of Cases	Primary Healing Per cent	Relative Five-Year Healing Per cent	Absolute Five-Year Healing Per cent
Not treated	4			
I—(a) No nodes palpable, lesion 1.5 cm. or less	82	99	85	56
(b) Lesion over 1.5 cm.	81	93	58	38
II—Nodes palpable	38	65	29.6	21
III—Inoperable	80	20	—	1.2
Total	285			

2. In the Group I cases 95 per cent showed primary healings, 2.5 per cent of which recurred without subsequent healing; 71.9 per cent showed relative five-year healings; 47 per cent showed absolute five-year healings. The small lesions treated locally only showed 85 per cent relative five-year healings, the large lesions treated

locally only showed 58 per cent relative five-year healings; the small lesions treated locally and to the lymph-bearing areas prophylactically showed 86 per cent relative healings, and the large lesions in this group showed 59 per cent relative healings.

3. In the Group II cases 65 per cent showed primary healings, 29.6 per cent had relative five-year healings; 21 per cent absolute five-year healings.

4. In the Group III cases only one of 80 showed five-year healing; the rest died from metastases.

5. In the Group I cases, 34, or 20 per cent, developed enlarged lymph nodes.*

REFERENCES

1. BLOODGOOD, JOSEPH C. Lesions of the oral cavity and of the jaws, including the temporal fossa, orbital cavity, and sinuses. *Practice of Surgery*. Dean Lewis. W. F. Prior Co., Hagerstown, Md. Vol. IV, Chapter 4, p. 71.
2. BREWER, GEORGE E. Carcinoma of the lip and cheek. *Surg., Gynec. & Obst.*, 1923, 36, 169-184.
3. FISCHER, ELLIS. Rational therapy for cancer of the lower lip. *Am. J. Cancer*, 1931, 15, 1334-1337.
4. SHEDDEN, WILLIAM M. The results of surgical treatment of epithelioma of the lip from the Massachusetts General Hospital and the Cancer Commission of Harvard University. *Boston M. & S. J.*, 1927, 196, 262-270.
5. STENSTROM, WILHELM. Dosage one and two centimeters under the skin from unfiltered x-rays. *J. Cancer Research*, 1924, 8, 18-21.

* For discussion see page 88.



TREATMENT AND RESULTS IN CARCINOMA OF THE LIP*

A REPORT OF 130 CASES

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IN PERHAPS no other malignancy is the physician in so favored a position as when dealing with carcinoma of the lip. The appearance of an ulcer on the lip that fails to heal, by virtue of its exposed and prominent position, leads to early recognition. Delays, for which physicians and patients are about equally responsible, occur, but not with the consistent frequency observed in the diagnosis of most other malignancies. In addition, carcinoma of the skin, of which cancer of the lip may be considered as one of the more frequent sites of occurrence, is relatively benign as contrasted with a large number of malignancies occurring elsewhere. In the management of carcinoma of the lip, the physician has at his disposal two agents of demonstrated value, namely, surgery and irradiation, and the results of effective treatment in early cases of carcinoma of the lip are probably unrivalled by those of any other type of malignant neoplasm.

The special interest in carcinoma of the lip hinges about the most appropriate type of treatment. For most squamous cell carcinomas of the skin elsewhere, irradiation in most centers where both types of treatment are available has superseded surgery. In the lip, however, the results of adequate, early surgery have been so satisfactory that many have been unwilling to substitute an agent of questioned equal worth. Several of those who have accepted the conservative plan of irradiating both the neck and the local lesion on the lip, however, believe that many lymph nodes are needlessly removed by surgeons who regularly do the complete operation, and contend that their results are just as good,

and that irradiation spares the deformity of the lip occasionally resulting from surgical excision.

What every conscientious physician desires for his patient is the greatest degree of protection and assurance of complete eradication of the disease, with least danger to life. The matters of conservative non-operative or surgical treatment with its attendant apprehensions, deformity and convenience are considerations of consequence, but only of secondary concern.

A number of studies have shown that when the submaxillary and submental lymph nodes are routinely removed in early cancer of the lip histologic metastatic involvement is present in only about 25 per cent of the cases. As contrasted with cancer of the breast or tongue, carcinoma of the lip must be conceded to be a more benign type of neoplasm in which lymph node metastases do not occur early with such regularity. Nevertheless the results of simple "V" excision and the complete operation [66 per cent five-year cures for the former, and 92 per cent for the latter (Brewer)] are so striking as to indicate that effectual and adequate management of the lymph nodes is a significant item in dealing with cancer of the lip. To those experienced in the removal of the lymphatic drainage area in malignancy, it is difficult to escape the impression that the assertion of the microscopist that the removed submaxillary or submental lymph nodes are free from cancer has the same significance as when he fails to find evidence of metastatic cancer in the axillary lymph nodes. Certainly the biologic test as manifested in the absence of lymph node

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involvement with the lapse of time is a far more reliable criterion than the statement of the pathologist that there is no microscopic evidence of metastasis. We have the impression as concerns the absence or presence of lymph node involvement in cancer of the lip, that palpation and gross examination of the removed nodes are almost as equally reliable in the detection

favor and practice this conservative plan have not published convincing statistics to bear out their contention. It might well be asked in how many early cases treated conservatively with irradiation does manifest involvement of the regional lymph nodes subsequently occur, demanding interstitial implantation of radium or surgical removal. We feel that one of the obligatory

TABLE I
RESULTS IN CARCINOMA OF THE LIP (130 CASES)
January, 1925—April, 1932

	Cases	Surgery Only	Irradiation Only	Combined Surgery and Irradiation	Recurrences	Total Deaths	Deaths Due to Carcinoma	Cancer-Free	
								3 years	5 years
Early without nodes (1)	41	16	8	17	1	8	4	10	5
Late with nodes (2)	53	9	6	38	10	6	5	12	2
Late with fixed nodes	5*			1	1	4	4		
PRIMARY GROUP TOTAL	99	25	14	56	12(11%)	18(19%)	14(14%)	22	7
RECURRENT GROUP TOTAL (3)	31**	7	11	11		16(51%)	13(42%)	4	3

FOLLOW-UP IN 84 PER CENT TOTAL MORTALITY—26 PER CENT MORTALITY DUE TO CARCINOMA—20.7 PER CENT

(1) 11 cases never returned after initial therapy.

(2) No follow-up on 3 cases.

(3) No follow-up on 5 cases.

* 4 hopeless. Not treated.

** 2 not treated

of the presence of cancer as is microscopic examination.

Certain it is when the lymph nodes are manifestly involved that roentgen therapy as a single agent is a futile remedy. Our experience has been that surgical extirpation of the involved lymph nodes combined with the interstitial employment of radium emanations (gold seeds) is the most effective in such instances. From our own experience we have been unable to determine how effective roentgen radiation is in destroying minute metastases that are not apparent in the lymph nodes. Those who

requisites in pursuing the conservative irradiation plan is a frequent (monthly at first) check-up of the patients. Our patients, though they come largely from an agricultural community, are in a measure a migratory population, as is easily demonstrated in follow-up efforts. They are almost entirely charity patients, and come from the four quarters of the state, and a monthly attendance at the outpatient clinic is, necessarily, out of the question. In consequence we have continued the policy of routinely excising the primary lymphatic drainage area in cancer of the lip. In the

majority of instances the lesion on the lip has also been dealt with surgically, roentgen-rays or radium being used as the sole therapeutic agents in very superficial localized, or very broad lesions of the lip. Our plan of dealing with the various types of carcinoma of the lip will be discussed at greater length below.

ticular therapeutic agent employed by the physician whom he consults.

REVIEW OF OUR MATERIAL

Since January, 1925, when the Cancer Institute of the University of Minnesota School of Medicine was opened, to April 1, 1932, 138 cancers of the lip have been

TABLE II

RECURRENT GROUP OF 31 CASES, 3 DIED WITHOUT EVIDENCE OF RECURRENCE AND WITH CAUSE NOT ATTRIBUTABLE TO CARCINOMA. THIRTEEN DIED DURING THE COURSE OF THE DISEASE AS FOLLOWS:

Age	Duration after Recurrence	Cause of Death	Treatment	Remarks
53	Unknown	Carcinoma	Not treated	Hopeless
42	10 months	Carcinoma	Not treated	Hopeless, due to extent and infection in neck
66	48 months	Carcinoma	Injection gasserian ganglion	Hopeless, recurrence in lip and neck
57	Unknown	Carcinoma	Radium therapy only	Hopeless, large ulcerated lesion—never cleared up
67	27 months	Asphyxia	Resection mandible	Recurrence in lip and neck, operative death
54	13 months	Atelectasis 27 days after operation	Neck dissection and radium implantation	Recurrence in neck
38	12 months	Carcinoma	1. Resection mandible 2. Later radium	Recurrence in neck never cleared up; died here 9 months later
65	50 months	Carcinoma	Combined surgery and x-ray and radium	Recurrence in lip and neck; died here 2 months later
70	33 months	Carcinoma	1. Combined surgery and irradiation 2. Later, irradiation	Recurrence in neck, never cleared up
74	20 months	Hemorrhage	Excision lip and irradiation	Recurrence in lip and neck, erosion jugular vein
70	22 months	Carcinoma	1. Combined surgery and irradiation	1. Recurrence in lip
67	Unknown	Carcinoma tongue	Excision lip only	2. Secondary recurrence Recurrence lip
62	Unknown	Carcinoma cervix with metastasis to lung	Excision lip, neck dissection	Recurrence lip

One of the functions of a symposium should be a pooling of experiences, out of the discussion of which should be elaborated certain definite conclusions as to which is the preferred method of treatment. A review of this character fails in its objective unless this end is attained. With the cooperative effort in cancer treatment becoming manifest throughout our country, the patient should be in a position to accept the acknowledged preferred treatment and not be forced to accept the par-

studied. Eight of these cases refused all types of therapy, therefore the statistical study is based upon 130 cases.

Ninety-nine of these had received practically no treatment prior to admission and are therefore considered as primary cases. There were also 31 cases of recurrent lesions on the lip or neck, or both, when they first visited our Tumor Clinic of the Out-Patient Department. One hundred and eleven of these patients have been followed at fairly regular intervals, either by return visit,

letter, or through correspondence with their local physicians. We have therefore maintained an 84 per cent follow-up in this group. Fifteen of the primary and 5 of the recurrent group have not been traced for the last six months.

Age. The youngest patient in the whole group was thirty-three years old, and the oldest, a female, was ninety years. Thirty-four per cent were in the sixth decade, and 25 per cent in the fifth decade. We had only 3 cases below forty years of age.

Sex. There was the usual striking predominance of males over females, there being only 4 cases, or 3.1 per cent, of carcinoma of the lip in females in the group.

Position. In this series the upper lip only was involved in 2 cases (1.6 per cent). One of these, in a man, was diagnosed as basal carcinoma, and the other, in a woman, as an infiltrating type of squamous carcinoma. There was no predominance of one side of the lower lip over the other.

When these cases were first seen, a biopsy was taken and a careful microscopic study made. The various sections were graded upon the cellular differentiation as pointed out by Broders. We have felt that microscopic grading is another aid that must be considered carefully in appraising the prognosis. We have not, however, varied the treatment a great deal whether the tumor is graded 1 or 4.

The clinical factors have proved to be of greater aid to us than any laboratory procedure. In every case we have tried to make special notation as to the extent of the primary lesion, whether it is infiltrative or proliferative, and the presence or absence of palpably firm, discrete, regional nodes (clinically or at operation). Not infrequently it has been our experience that palpable nodes have failed to show microscopic evidence of disease. Our usual procedure, however, has been to make sections of each node present. Possibly if a large number of sections of each node were made we would find more nodes with microscopic involvement, but such procedures are impractical.

THE PRIMARY GROUP

Duration. The duration of the lesion in these cases varies from six months to over five years. There were 22 cases with the duration less than six months, and the same number with the duration over four years.

Grouping of Cases. Cases of this group have been subdivided into three classes depending upon the presence of involved nodes, clinically or operatively, and if they were fixed to surrounding structures or nodes. The fixation probably means that the carcinomatous metastasis has broken through the capsule of the node and invaded the neighboring tissues. The primary lesion has been of the infiltrative type in 88 cases, and proliferative in 11 cases.

There were 41 cases of early lesions without regional nodes being involved; 53 cases in which the nodes were palpable, and 5 cases in which the nodes were fixed.

EARLY LESIONS WITHOUT PALPABLE NODES

The primary lesion was of the infiltrative type in 38 cases and of the proliferative in 3 cases. In the class of early lesions without involved nodes the duration was fairly short. In 9 cases the duration was less than six months; in 12 the duration was between seven and twelve months; however, the lesion was present over four years in 8 cases.

We have employed no inflexible rules in the management of these cases of carcinoma of the lip, but have permitted ourselves to be guided largely by the findings in each case. The usual treatment has been a combination of surgery and irradiation. Latterly we have been treating the local lesion more frequently by irradiation alone. The lesion on the lip has been first excised by a wide "V" type of incision, followed by one exposure of the lip to roentgen radiation (30-50 per cent S.E.D.). In those instances where the excision of the lesion has narrowed the oral opening considerably, we have found that a lateral incision on one or both sides usually suffices to correct the deformity. In previous years we usually employed the Stewart operation for recon-

structing the lip and in more recent years a pedicled lateral flap swung down from the upper lip has occasionally been employed. However, we have found the widening of the mouth obtained by suturing the mucous membrane in the lateral incision (Fig. 1) so effective and simple as to warrant its routine employment where a plastic repair appears indicated. After about four weeks a neck dissection has been done in which

treated in this manner. There have, however, been several that have had surgical treatment only, and a few that have been treated by radiation alone. In those instances in which the lesion on the lip responded favorably to roentgen or radium irradiation alone, excision of the submaxillary and submental lymph nodes has almost invariably been done a short time later, followed by roentgen irradiation of

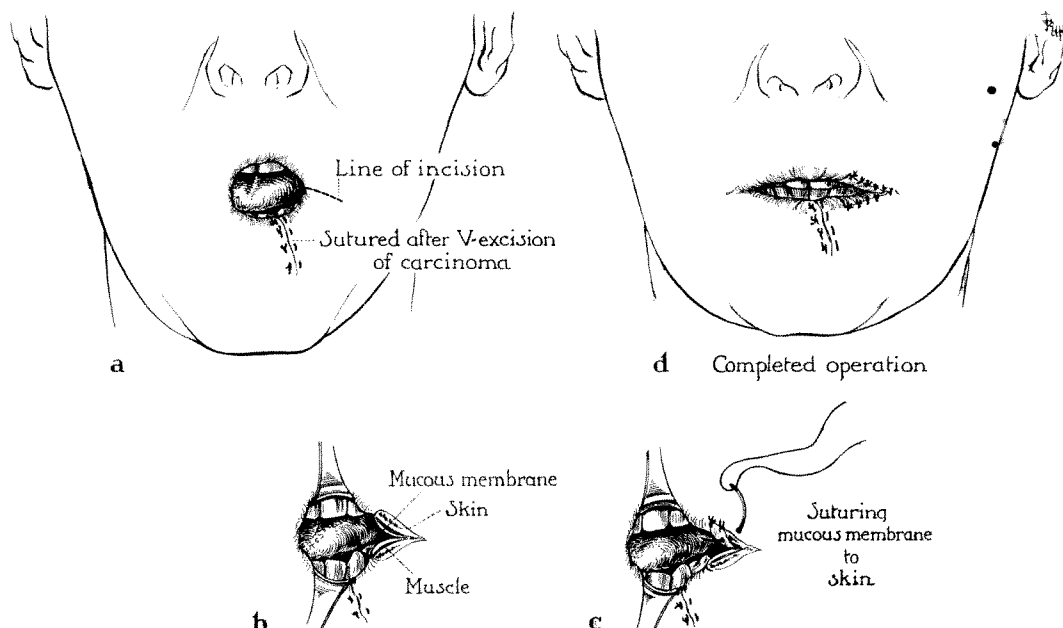


FIG. 1. A simple method of enlarging the "fish-mouth" deformity after "V" excision of a lesion of the lip (O.H.W.). The method may be employed, also, in the rarer instances of carcinoma of the upper lip. We have also found it useful in enlarging the oral opening after unsatisfactory results following more complicated types of plastic repair.

the contents of both submaxillary triangles and the submental space have been excised. Whenever indicated, as determined by the presence of manifest gross involvement of the submaxillary lymph nodes on one or both sides of the neck, a block dissection has been done. When the incision has healed a series of deep roentgen treatments (120-160 per cent S.E.D.) have been given. Roentgen radiation to the lip alone has been limited largely to very superficial lesions, the removal of which would demand excision of practically the entire lower lip.

The majority of the cases have been

treated in this manner. We have not employed the endotherm, but have used sharp dissection throughout.

The combination of surgery and irradiation has been used in 17 cases; irradiation alone in 8 cases; surgery alone in 16 cases (in 4, only excision of the lip was done).

One case did not improve after irradiation of the lip and regional nodes, and died twenty-two months after treatment. There was one recurrence in the lip thirty-two months after excision of lip and neck dissection. This recurrence was treated by roentgen irradiation of the lip and neck. He

was free from tumor when seen two months later.

Mortality. There have been 8 deaths, 4 of which were not attributable to cancer who died eight months, nine months, twelve months, and thirteen months after initial therapy. The 4 who died, whose cause of death could be attributed to carcinoma, lived three days, two months, nineteen months, and twenty-two months after initial therapy (see Table III).

more than four years in 13 cases. When we compare these figures with the early group the duration does not appear to be of very much importance.

The primary lesion was of the infiltrative type in 45 cases, and proliferative in 8 cases.

In this group there has been a much stronger tendency to combine surgery with irradiation. In only 9 cases was surgery used alone, in 6 cases irradiation alone, and in 38 cases the combination

TABLE III

THE DEATHS MAY BE TABULATED AS FOLLOWS: PRIMARY GROUP OF 99 CASES, 18 DEATHS, 4 DIED OF CAUSES NOT ASCERTAINED BUT WITHOUT EVIDENCE OF RECURRENCE. FOURTEEN DIED DURING THE COURSE OF THE DISEASE AS FOLLOWS:

Age	Duration after Treatment	Cause of Death	Treatment	Remarks
60	3 days	Hemiplegia	"V" excision lip	Postoperative death
75	5 days		Submaxillary neck dissection	Hopeless, due to infection
61	4 months	Carcinoma	Not treated	Hopeless. Very extensive
85	8 months	Carcinoma	Radium only	Hopeless
80	1 month	Melanoma	Excision lip, irradiation	Hopeless, due to extent and senility
80	Unknown	Carcinoma	Irradiation only	Recurrence, 8 months after initial therapy
78	Unknown	Carcinoma	Irradiation, neck dissection	Recurrence lip and neck, treated with radium and x-ray
71	15 months	Recurrence	Combined surgery and irradiation	No recurrence in lip or neck
72	4 months	Carcinoma lung (metastasis)	Combined surgery and irradiation	Never completely healed
66	22 months	Carcinoma	Irradiation	No recurrence
68	19 months	Carcinoma larynx	Excision lip and neck dissection	
—	4 months		Excision lip and neck dissection	
66	7 days	Carcinoma	X-ray and radium	Died at home
72	2 months	Carcinoma	Excision lip and x-ray lip	Died at home

Of the remaining cases we have no follow-up on 11 who never returned after they were first treated. The duration of the other 22 cases is as follows: up to six months, 6 cases; seven to twelve months, 2 cases; thirteen to eighteen months, 1 case; nineteen to twenty-four months, 3 cases; twenty-five to thirty-six months, 4 cases; thirty-seven to forty-eight months, 1 case; over forty-eight months, 5 cases.

CARCINOMA OF THE LIP WITH PALPABLE NODES

Duration. There were 53 cases in this group. The duration did not appear to be of very great consequence as the duration was less than six months in 14 cases, and

of surgery and irradiation was employed.

Recurrence. We have had 10 recurrences of which 2 were in the lip, 3 in lip and neck, 3 in neck, and in 2 the position was not stated. Most of these recurrences appeared during the first six months subsequent to treatment, however one appeared after three years. Six of the cases are dead, 2 of which died during treatment.

ADVANCED GROUP

Of the 5 cases in the advanced group, 4 were considered hopeless and no treatment was advised. In the other case a combination of extensive dissection followed by deep roentgen therapy was used. A recurrence in the neck appeared two months

later which was treated, and the patient is now living and well twenty-seven months after the first treatment.

SUMMARY OF RECURRENCES IN PRIMARY GROUP

There were 12 recurrences in the primary group, 7 of which appeared within the first six months, 2 between seven and twelve months; 2 between twenty-five and thirty-six months, and 1 after thirty-six months. Four of the recurrences were in the neck, 3 in the lip, 3 in the lip and neck, and in 2 the location of the recurrence was not stated. Ten of these cases were living with recurrences under control when last seen.

RECURRENT GROUP

There were 31 cases in this group, and all had their primary lesion in the lower lip. Their initial treatment elsewhere consisted of surgery only, in 15 cases, irradiation only, in 8 cases, and surgery and irradiation in 8 cases.

Duration and Position of Recurrence. Upon admission the recurrence was present on the lip in 14 cases; in the neck in 11 cases, and lip and neck in 6 cases. These lesions had been present less than six months in 16 cases, between seven and twelve months in 6 cases; thirteen to eighteen months in 2 cases; nineteen to twenty-four months in 2 cases; two to three years in 1 case; three to four years in 2 cases, and no record was given in 2 cases.

Four of these cases were considered too far advanced to be treated other than palliatively. In 7 the recurrence was treated with surgery only, in 11 cases with irradiation only, and in 11 with a combination of surgery and irradiation. All but 5 of these cases have been followed. Sixteen are dead, of which the cause in 13 is known to have been cancer.

Of those who have been traced, 3 are free from symptoms less than six months; 1 is free less than one year; 2 less than eighteen months; and 4 have been free for more than three years.

Upon the basis of the 31 cases in this group, the mortality has been 16 cases, or 51 per cent.

SUMMARY OF RESULTS (SEE TABLE 1)

In the 99 primary cases, surgery was used alone in 25 cases; irradiation alone in 14 cases; and a combination of surgery and irradiation was employed in 56 cases. There were 4 cases considered hopeless and not treated. There were 12 recurrences of which 2 are dead, and there was one case who was unimproved and subsequently died. One of these recurrences was in the early group, 10 in the group with involved nodes, and one in the advanced group. There were 18 deaths (mortality, 19 per cent), 14 of which were attributed to carcinoma (mortality on this basis of 14 per cent). We have no follow-up in the last six months on 14 cases. In this primary group there are 22 cases that have been followed who are living and free from symptoms three years after initial treatment, and 7 of which are living and well five years after treatment.

In the 31 recurrent cases no treatment was advised in 2 cases; surgery was used alone in 7 cases; irradiation alone in 11 cases; and a combination of surgery and irradiation in 11 cases. Fifteen cases are now free from symptoms, 4 of which have gone more than three years since their initial treatment. There have been 16 deaths, 13 of which may be attributed to carcinoma.

SUMMARY AND CONCLUSIONS

The results of treatment for cancer of the lip compare favorably with those of any malignancy. Failures are usually due to delay in receiving adequate treatment. In this group of 130 cases there have been 34 deaths (26 per cent); in 26 instances (20.7 per cent) death was due to cancer or a cause associated with the treatment of the lesion. Surgery has been the mainstay of treatment and roentgen rays and radium have been employed as essential adjuncts. It is believed that surgical removal of the submental and submaxillary lymph nodes affords the patient, with an early lesion, more protection than conservative irradiation.*

* For discussion see page 88.

AN OPERATION FOR EPITHELIOMA OF THE LIP*

By JEROME P. WEBSTER, M.D.

NEW YORK CITY

THE purpose of this paper is to present a type of operation which is useful in cases of primary epitheliomata involving a moderate or considerable portion of the lower lip. There is no attempt to discuss the treatment of neck metastasis.

With increased skill in the therapeutic application of radium and roentgen rays, with new and more effective methods of making use of these agents, with larger amounts of radium available in some institutions, and with higher powered roentgen-ray machines, in certain instances it is possible to eradicate the primary lesion by these means, and to cause but little alteration in the appearance and in the function of the lip. All too often, however, the dosage available is insufficient, and the physician employing these agents is not adequately trained in their proper application, with the result that in many instances the disease is not arrested.

Thorough surgical treatment is better than ineffectual radiation therapy, and inadequate excision is worse than optimum treatment by radiation. Interference with insufficient treatment by either method stimulates the diseased tissue to increased activity. As a result, subsequent eradication is rendered more difficult; a larger amount of tissue must be excised; the neoplasm may become widely disseminated; and finally, the cosmetic and functional results of later operations are relatively poorer.

A microscopic examination should be made of all primary lesions; for only with the data found thereby can the nature of the diseased tissue be definitely known and the diagnosis of malignancy be confirmed or disproved. An excision of the primary lesion with a wide margin of safety combines biopsy and good therapy.

It is essential in surgical excision of the primary epitheliomatous lesion that a sufficiently wide margin beyond the lesion be excised to prevent the possibility of leaving any portion of the diseased tissue *in situ*. Should not all of the tumor be removed, reappearance is bound to occur. One should not, therefore, be influenced by the size of the defect resulting from such a wide excision. The primary consideration is the elimination of the disease; secondary to this is the desire to obtain a satisfactory cosmetic and functional result.

Many small primary lesions may be readily repaired by simple "V"-shaped excision. This operation may be performed in the office or dispensary, under a local anesthetic, by an unassisted operator if necessary, and the patient does not have to enter a hospital. The stitches may be removed early, without leaving deforming scars, and the appearance of the lip is practically unchanged after this procedure. Even somewhat larger lesions may be excised by the "V"-method. This may leave a temporary tightness of the lip, but the deformity will be overcome in time by the gradual stretching of the lip from daily use.

There is a limit, however, to the width of tissue which may be excised without leaving a permanent deformity. Excision of larger lesions involves the problem of tissue replacement, and countless methods have been devised to repair these defects. In many of these operative procedures a portion of tissue is transplanted from the cheek, the chin, or from the neck, and the mucous membrane is brought over as well as possible to form a new vermilion border and a lining of the new lip. With many of these procedures, tissue from the cheek is drawn in from the sides and a tight lower

* From the Department of Surgery, College of Physicians and Surgeons, Columbia University and the Presbyterian Hospital, New York. Read in a Symposium on Cancer of the Lip, Seventeenth Annual Meeting, American Radium Society, New Orleans, La., May 9-10, 1932.

lip is produced. This traction of tissue towards the median line, in order to form the lower lip, inevitably draws the outer edges of the upper lip more closely together and causes this lip to protrude beyond its

ance. It consists in turning a wedge-shaped flap from the upper lip to fill one half of the "V"-shaped space caused by excision of the lower lip together with the epithelioma.

The operation is usually done under local

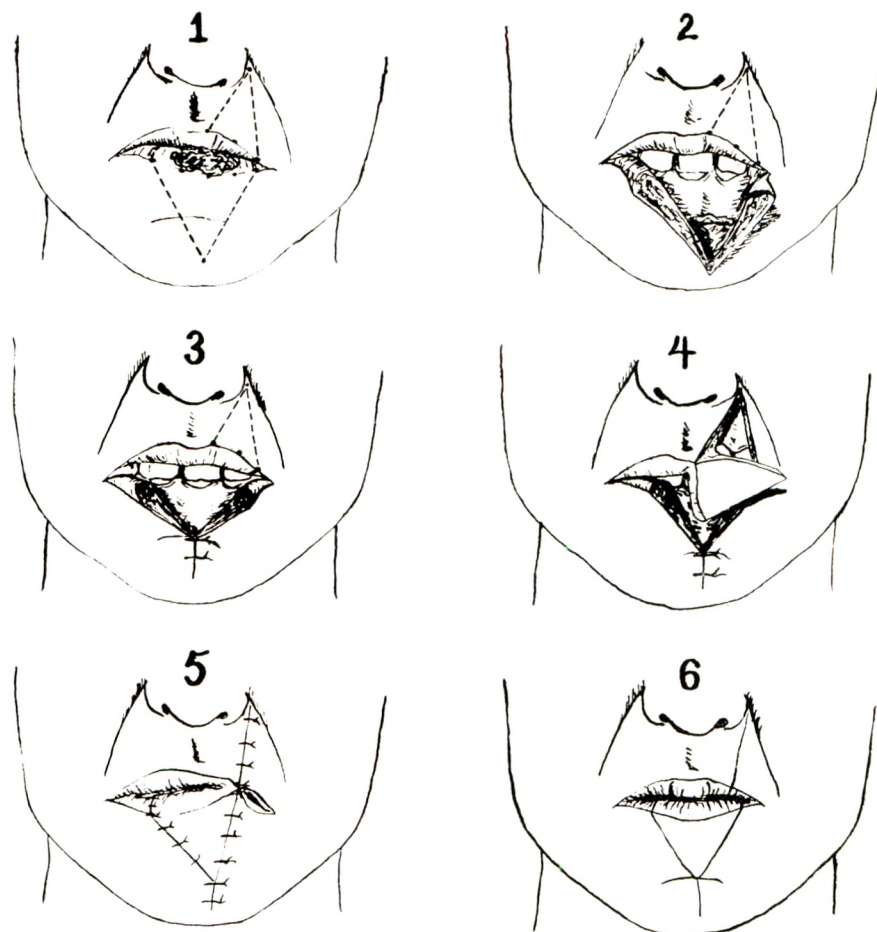
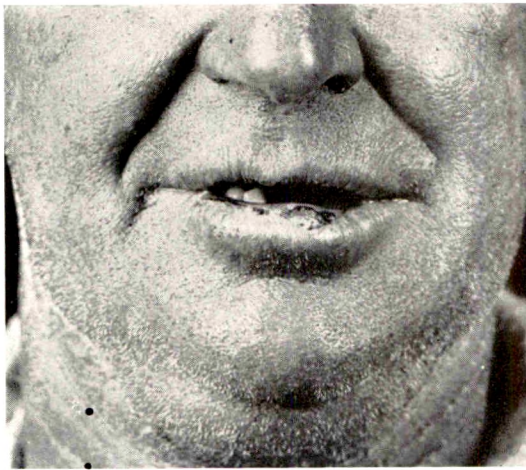


FIG. 1. Steps of operation for rotation of upper-lip flap into lower-lip defect, with the pedicle bridged between both lips. (1) Epithelioma and outlines of incisions in lips; (2) Epithelioma excised and muscle overlying the chin undermined; (3) Skin and mucous membrane sutured up to the level of the labio-mental fold; (4) Upper-lip flap being rotated into the lower-lip defect.—Note that the skin and lip margin are severed on the outer side. On the inner, pedicle side, the incision is carried through the skin to its junction with the vermilion border and the mucous membrane is left intact at a higher level; (5) Flap sutured in position with all denuded surfaces covered over. The pedicle forms a bridge between the lips making two openings to the mouth; (6) Pedicle severed and lip margins reformed.

natural position. There then exists a tight, retracted lower lip and a relaxed upper lip projecting beyond it.

The operation here described prevents this discrepancy between the two lips and replaces the tissue which has been excised with tissue similar in structure and appear-

ance, by injecting the infraorbital and mental foramina. The pedicle, attached to one corner of the flap at the lip margin, may either be bridged across between the two lips and severed at a subsequent operation, or the pedicle may be used to form the new commissure of the mouth.

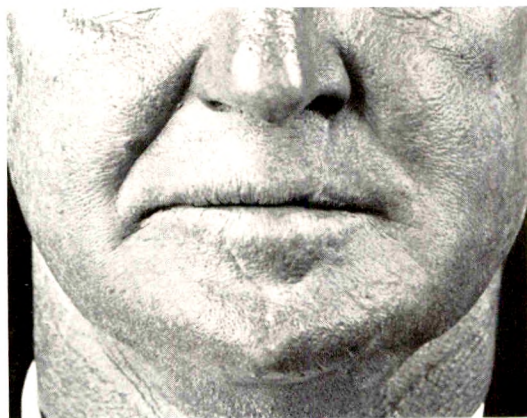


A

FIG. 2. Case 1, illustrative of upper-lip pedicle bridged between both lips. A. Epithelioma appearing in two portions of the lower lip, before operation.

This type of operation has been in use for at least ninety-five years. In so far as investigation has disclosed, Pietro Sabattini of Italy was the first to devise this method.¹ In 1837 he successfully used a pedicled lower-lip flap to repair an upper-lip defect, in a case where the upper lip and the nose had been slashed off with a sabre.

Sophus August Vilhelm Stein of Copenhagen² in 1847 excised a large epithelioma of the lower lip and turned down two adjacent flaps from the middle of the upper lip, each flap having its own pedicle situ-



B

FIG. 2. Case 1, illustrative of upper-lip pedicle bridged between both lips. B. Front view, five months after division of the pedicle.

ated laterally. Three openings were thus made in the mouth, as the adjacent edges of the rotated flaps and those of the upper-lip defect were not sutured at the first operation, but these edges were freshened and approximated subsequently when the pedicles were severed. Stein's method was with much reason both praised for its ingenuity and condemned^{3,4,17} for its complicated technique and for the tendency of its pointed, narrow flaps to slough.

In 1863 Gurdon Buck of New York^{5,7}



C

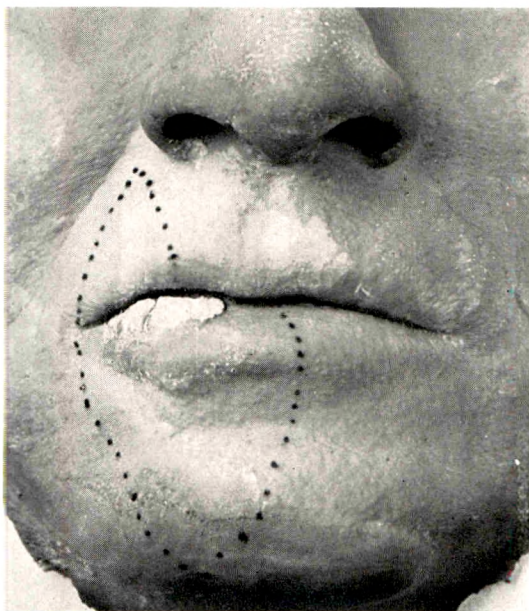
FIG. 2. Case 1, illustrative of upper-lip pedicle bridged between both lips. C. Postoperative profile view, showing the normal appearance of the lips.

used a flap from the right side of the lower lip, pedicled at the vermilion border and adjacent skin, to fill a defect caused by noma in the right side of the upper lip. Later in that decade he performed other similar operations.^{6,7}

J. A. Estlander of Helsingfors⁸ reported in 1872 that he had independently devised and for several years had used an operation whereby a flap from the outer border of the upper lip was rotated to fill a defect in the outer border of the lower lip after ex-

cision of an epithelioma. The pedicle formed the new commissure of the mouth. Estlander published several articles in various languages^{9,10,11} and went much more deeply into the mechanism of the operation than any author before or since his time.

In 1898 Robert Abbe of New York¹² reported the use of a wedge-shaped flap from the lower lip pedicled with lip margin and skin to increase the amount of tissue in a tight upper lip, caused by repair of a dou-

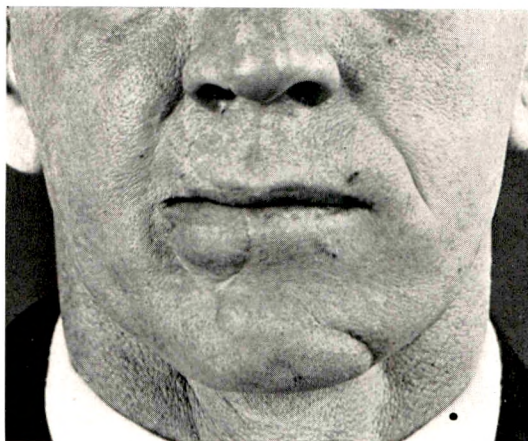


A

FIG. 3. Case II, illustrative of the operation employed when the epithelioma is located near the commissure of the mouth. The pedicle forms the new commissure. A. Cast showing the epithelioma and the lines of incision.

ble harelip. The pedicle was bridged between the lips. He left a portion of the pedicle, the flap and both lips denuded, and subsequently, after freshening the edges, severed the pedicle and approximated the adjoining edges.

G. Neuber of Kiel¹³ briefly reported in 1899 an operation identically similar to Abbe's. Lexer speaks of it as the "Abbe-Neuber" operation,¹⁹ but Abbe, preceding Neuber, had already done much to popularize it. This type of operation has been extensively used—notably in this country

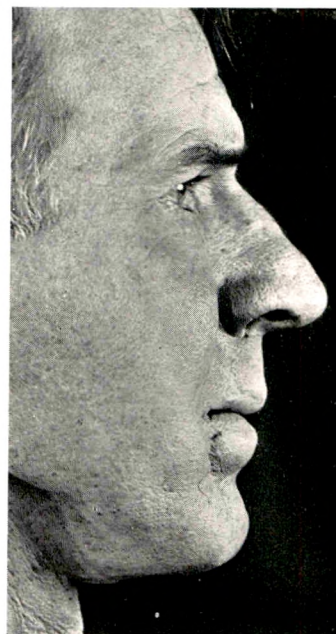


B

FIG. 3. Case II, illustrative of the operation employed when the epithelioma is located near the commissure of the mouth. The pedicle forms the new commissure. B. Condition three years after the operation of rotating the upper-lip flap and later of widening the mouth.

by T. W. Brophy—for the relief of a tight upper lip.

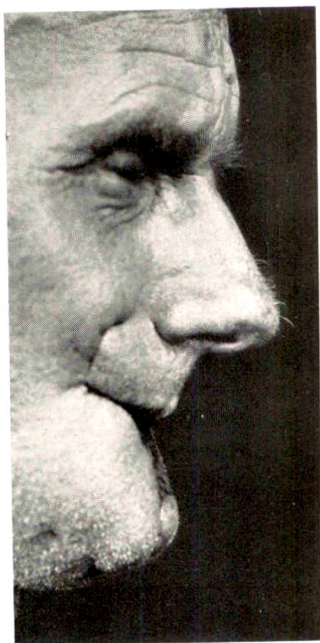
Vilray P. Blair and his assistant, J. Barrett Brown, of St. Louis,²² have seen the



C

FIG. 3. Case II, illustrative of the operation employed when the epithelioma is located near the commissure of the mouth. The pedicle forms the new commissure. C. Profile view showing normal lip contour.

value of leaving none of the cut edges denuded, and the operation described here is largely based on their technique. Many others have described the methods or



A

FIG. 4. Case III, illustrative of the release of a tight lower lip caused by Bürow's operation for reforming the entire lower lip. A. Profile view before the release operation, showing the lower lip so tightly retracted that a dental plate could not be worn in the edentulous mouth.

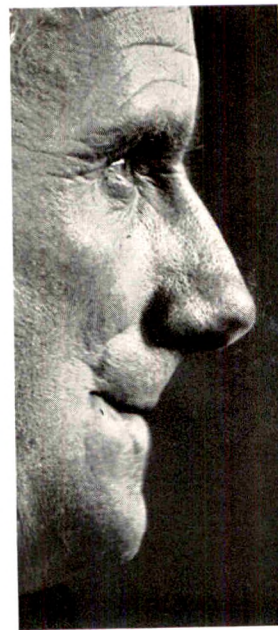
have reported cases operated by the methods of the various men mentioned above.^{14,15,16,17,18,19,20,21,23,24}

In the operation recommended here, a wedge of tissue in the form of an isosceles triangle, containing the epithelioma and leaving a wide margin beyond it, is excised from the lower lip. The mucous membrane on the lip side of the sulcus is incised laterally. The muscular tissue of the chin is separated from its attachment to the mandible and the lower portion of the "V" is brought together with sutures as far as the mento-labial fold.

When the lesion does not involve the commissures, a wedge-shaped flap is cut from the upper lip in the form of an isosceles triangle. Its base is at the vermillion

border, equal and opposite to the right (or left) half of the defect in the lower lip, as previously marked out, and its apex is at the naso-labial fold; its height is equal to the distance between the mento-labial fold and the vermillion border of the lower lip. Section is made through the entire vermillion border and lip margin on one side of this wedge-shaped flap of the upper lip. Tissue is left at the other lip margin of the flap to form the nutrient pedicle; the incision is carried down superficially on this pedicle side to the junction of the skin and vermillion border, but the mucous membrane is preserved at a higher level so as to leave intact the superior coronary artery to maintain nourishment to the flap.

The upper-lip flap is then rotated downwards 180° and the opposing edges of skin and of mucous membrane are approximated with interrupted sutures. The defect in the upper lip is closed in like manner and the skin of both the upper and lower lips is brought together at its junction with the



B

FIG. 4. Case III, illustrative of the release of a tight lower lip caused by Bürow's operation for reforming the entire lower lip. B. Profile view after increasing the size of the lower lip by a flap from the upper lip. For comparison no dental plate is worn.

vermilion border. The denuded areas of the pedicle are completely closed over by suturing adjacent edges. This constitutes one of the important features of this operation, because no granulating surfaces or cicatricial contraction can occur after such approximation.

The patient is fed for the first twenty-four to forty-eight hours on fluids given through a tube, and mouth washes are given by the same means. Spoon-feeding and soft diet may then be given with later progression to regular diet.

Beginning about the tenth or twelfth day the pedicle is compressed at intervals by a rubber-covered clamp for increasing periods of time to stimulate the ingrowth of blood vessels to the flap from the adjoining lip tissue. The pedicle is severed about the sixteenth or seventeenth day after operation and the denuded areas on the lip margins are closed by utilizing the tissue of the pedicle.

Should the lesion be located near one of the commissures of the mouth, the pedicle can be used to form the new commissure, as in the operation of Estlander. This tends to shorten the mouth slightly on that side, and a subsequent operation to widen the mouth may be necessary, so that the two sides may be equal.

In those cases where a very extensive lesion has previously been excised and the defect closed by another procedure, which has left a greatly tightened lower lip and a protruding upper lip, the lower lip may be divided so as to form a wedge-shaped defect by the retraction of the tissue on either side of the incision. A flap may then be rotated down from the upper lip to fill this defect, as in the operation first described above.

The tissue of the flap from the upper lip in all of these instances is similar in every way to the remnants of the lower lip on either side of the operative defect. There may be some temporary lymphatic stasis causing a swelling of the flap, but this subsides in time, and the late appearance of the lower lip is satisfactory. The upper and lower lips assume their natural position with no abnormal protrusion and the profile is hardly changed after this procedure. The functional result is excellent and the cosmetic appearance good. Such a procedure in the hands of a competent surgeon is to be advised where no expert radiologist with effective equipment is available.

SUMMARY

1. Radiation therapy for primary lip epitheliomata may be dangerous unless in expert hands with sufficient dosage.
2. Biopsy of all lip lesions should be made.
3. Excision with a wide margin combines biopsy and good therapy.
4. Simple "V"-excision suffices for small lesions; larger lesions require tissue replacement.
5. An operation is described whereby a vermilion-bordered, upper-lip flap is rotated into a lower-lip defect of twice its size.
6. Depending upon the location of the lesion, the pedicle may bridge between the lips or may form the new commissure of the mouth.
7. Tight lower lips caused by other procedures may be released and brought forward by this operation.
8. Where radiation therapy might fail, the primary lesion may be eradicated surgically by this method with good functional and cosmetic results.

BIBLIOGRAPHY

1. SABATTINI, PIETRO. *Cenno Storico dell'Origine e Progresso della Rinoplastica e Cheiloplastica* seguito dalla Descrizione di Queste Operazioni sopra un solo individuo. Bologna, 1838.
2. STEIN, SOPHUS A. V. *Læbedannelse (Cheiloplasty) udført paa en ny Methode*. Hospitals-meddelelser (Copenhagen), 1848, 7, 212-216.
3. VIDAL (*de Cassis*), AUGUSTE-THÉODORE. *Traité de pathologie externe et de médecine opératoire*. 4 ed. J.-B. Baillière, Paris, 1855, 3, 547-551.
4. THOMAS, FÉLIX. *Examen des principaux procédés de la restauration de la lèvre inférieure*. thesis Montpellier. Imprimerie typogra-

- phique de Gras, Montpellier, 1870, 20-23.
5. BUCK, GURDON. History of a case in which a series of plastic operations was successfully performed for the restoration of the right half of the upper lip and adjacent portions of the cheek and nose. *Transactions of the Medical Society of the State of New York*, 1864, 173-186.
 6. BUCK, GURDON. A contribution to plastic surgery. A case of destruction of the right half of the upper lip, neighboring portion of the cheek, and ala nasi. *Transactions of the American Medical Association*, 1870, 21, 233-238.
 7. BUCK, GURDON. Contributions to reparative surgery. D. Appleton and Co., New York, 1876, 20-87.
 8. ESTLANDER, JACOB AUGUST. En ny operationsmetod att återställa en förstörd läpp eller kind (A new operative method to restore a lost lip or cheek). *Finska läkaresällskapets handlingar*, 1872, 14, 1-16.
 9. ESTLANDER, J. A. Eine Methode aus der einen Lippe Substanzverluste der anderen zu ersetzen. *Archiv für klinische Chirurgie*, 1872, 14, 622-631.
 10. ESTLANDER, J. A. En metod att från den ena läppen fylla substansförluster i den andra och i kinden (A method of transplanting, in loss of substance, from one lip to the other and to the cheek). *Nordiskt Medicinskt Arkiv*, 1872, 4, 1-12.
 11. ESTLANDER, J. A. Méthode d'autoplastie de la joue ou d'une lèvre par un lambeau emprunté à l'autre lèvre. *Revue mensuelle de médecine et de chirurgie*, 1877, 1, 344-356.
 12. ABBE, ROBERT. A new plastic operation for the relief of deformity due to double harelip. *Medical Record*, 1898, 53, 477-478.
 13. NEUBER, G. Zur Hasenschartenoperation. *Verhandlungen der Gesellschaft Deutscher Naturforscher und Aerzte*, 1899, 71, *Med. Abt.*, 90-91.
 14. HAORDH, A. Ueber die Verwendung der Methode Estlander's bei Defecten der Wange und der Lippen. *Deutsche Zeitschrift für Chirurgie*, 1882, 16, 376-380.
 15. FORGUE, ÉMILE. Traitement du cancer des lèvres, ses procédés et ses résultats. *Montpellier médical*, 2. sér. 1890, 14, 53-63.
 16. FORGUE, E., et RECLUS, PAUL. Traité de thérapeutique chirurgicale. 2. éd. Masson et Cie., Paris, 1898, 2, 375-376.
 17. NÉLATON, CH., et OMBRÉDANNE, L. Les autoplasties. G. Steinheil, Paris, 1907, 53-55.
 18. LEXER, E. In, A System of Practical Surgery, v. Bergmann, v. Bruns and v. Mikulicz. Translated by W. T. Bull and W. Martin. Lea Brothers and Co., New York and Philadelphia, 1904, 1, 550-555.
 19. LEXER, E. In, Bier, Braun u. Kümmell's Chirurgische Operationslehre. 3te Aufl. Johann Ambrosius Barth, Leipzig, 1920, 1, 444-445 and 488-489.
 20. BROPHY, TRUMAN W. Oral Surgery: A Treatise on the Diseases, Injuries and Malformations of the Mouth and Associated Parts. P. Blakiston's Son and Co., Philadelphia, 1915, 541-556.
 21. DAVIS, JOHN STAIGE. Plastic Surgery, Its Principles and Practice. P. Blakiston's Son and Co., Philadelphia, 1919, 279 and 535.
 22. BROWN, J. BARRETT. Switching of vermilion-bordered lip flaps. *Surgery, Gynecology and Obstetrics*, 1928, 46, 701-704.
 23. BURDICK, CARL GOODWIN. Hare-lip and cleft palate; an analysis of 184 cases. *Annals of Surgery*, 1930, 92, 35-50.
 24. JOSEPH, JACQUES. Nasenplastik und sonstige Gesichtsplastik. Curt Kabitzsch, Leipzig, 1931, 581-586 and 599-600.

DISCUSSION OF SYMPOSIUM ON CANCER OF THE LIP

DR. ALTON OCHSNER, New Orleans, La. I hesitate to get up before this august group, a mere surgeon, and open the discussion on the treatment of carcinoma of the lip. Here in New Orleans we have been handicapped by having a relatively small amount of radium and our treatment is based largely on that fact. We have been forced to treat these cases operatively. We prefer in the cases in which the lesion is small, smaller than 1 cm. in diameter, to do a V-excision. For the larger ones we have used a modification of the Stewart incision. In all cases, whether treated with radium or not, we have always done a bilateral block excision of the glands of the neck. We have done this because we have found that 82 per cent of the cases were in Groups I or II and we felt that it

would be better to do a block dissection. All of our patients at the Charity Hospital are impossible to follow and it is difficult for us to draw many conclusions concerning the end-results. We have felt that because of this lack of observation we were probably doing the better thing by extirpating as rapidly as possible the glands of the neck in those individuals. I cannot report on the end-results because of the fact that we deal with a peculiar class of individuals. We get them from the bayous of Southern Louisiana and many of them have never been away from the bayous before and never will be again. It is only when we get bad results that we get them back. Unfortunately, many of the cases are hopeless from the beginning. We try to clean them up as well as

possible but the results are not satisfactory.

DR. ROLLIN H. STEVENS, Detroit. This wonderful symposium on cancer of the lip can only result in a very pertinent influence on all of us in our decision as to how these cases should be treated. It emphasizes several things. First, the necessity for a more uniform system of keeping our records. It seems to me this Society should either adopt the system of the American College of Surgeons or cooperate with them and adopt a new system. There are so many different factors entering into the pathology and treatment of cancer of the lip with varying results, as exhibited by statistics, that it is difficult to come to any conclusions from statistics alone. When we get many more statistics than we have now relating to cancer of the lip treated by surgery alone or by radiation alone, treating the lymph nodes by surgery or not at all, or by irradiation, perhaps we may draw some definite conclusions.

I think we can draw one conclusion from what we have heard today, and that is that the radiation treatment of the primary growth is the treatment of choice. While we have seen some beautiful work presented here in regard to plastic procedures on cancer of the lip, and some splendid statistics from this treatment, at the same time all that surgery seems to be quite unnecessary. I think we should regard it as interesting pathologic or biologic experimentation. We certainly get beautiful cosmetic results from proper irradiation, and why take up the patient's time with hospitalization, and why strike fear to his heart by telling him of the time he must spend in the hospital when proper treatment with irradiation will produce equally good or better results.

In the treatment of the glands of the neck we have a different proposition. I have not been able to decide which is the better method, but have used both methods. Just before I left home a patient, who had had carcinoma of the floor of the mouth with metastasis to the cervical gland which we had treated seven years before with radium, came in with a recurrence of involvement of a cervical gland in the same neighborhood. The involved gland only was removed at the time of the first treatment and was found to be a squamous cell growth. A second nodule appeared there later. We treated the neck with radium packs and the patient remained well seven years until a few weeks ago when the late recurrent nodule appeared in her neck. I presume it is malignant but I did not

have it removed and cannot prove it. I treated it with a radium pack only.

In another case of squamous cell carcinoma of the lower lip, which we treated by irradiation six years ago, a second carcinoma developed in the upper lip on the opposite side a few weeks ago. This growth disappeared promptly under roentgen irradiation. About two months later we found a gland at the angle of the jaw on the same side. Did that gland come from the growth on the upper lip or from the original growth on the lower lip of the opposite side? A block dissection of the neck was made and two small glands were found. These proved to be squamous cell metastases. It is very difficult to determine the nature of glandular involvement whether inflammatory or metastatic. As was pointed out, we must remember that metastasis follows along the glands, and if the latter are removed metastases, theoretically at least, are not so likely to occur. We should have more conferences on this subject, particularly on the treatment of glands of the neck.

DR. M. LENZ, New York City. There is one type of treatment of glands of the neck that has as yet not been mentioned, and that is the treatment by molded radium packs, according to the method used at the Curie Institute. At the Presbyterian Hospital where Dr. Webster and I frequently collaborate in the treatment of carcinoma of the lower lip we have adopted a few general principles which we follow in the majority of instances. Cases in which glands are not palpable are carefully followed clinically, but not treated in any other way; cases with palpable irremovable glands are treated by molded wax packs of radium at a 6 cm. distance from the skin; cases with palpable glands which can be removed have a unilateral upper neck dissection done, unless the lesion is in the midline, when a bilateral upper neck dissection is done. If the glands are proved microscopically to contain cancer, a lower neck dissection on that side is done in addition. As far as the treatment of the primary lip lesion is concerned Dr. Webster usually resects the more superficial carcinomas which are less than 1 cm. in diameter, whereas the larger and deeper ones are generally referred for radium therapy.

DR. W. E. COSTLOW, Los Angeles. One point I do not think was mentioned today in speaking of neck gland dissections is whether or not the surgeons precede this by thorough external irradiation. We believe this is an important point. In our clinic it is not our custom

to do routine neck gland dissections in carcinoma of the lip, but in cases in which this is done we always precede the dissection by thorough external irradiation, the dissection being carried out at least six weeks afterward. This procedure certainly will add something to the final results.

DR. OSCAR L. NORSWORTHY, San Antonio, Texas. There is one point that has not been brought out, although everyone treating cancer of the lip or mouth probably practices it, and that is cleaning the mouth. Practically all lip malignancies are associated with bad teeth, bad gums or some other foul condition of the mouth; and we are careful to put teeth and the entire mouth in good condition before discharging cases of cancer of the lip.

With reference to block dissection as against irradiation of the neck in cancer about the face, there are arguments for and against. I do not know whether we can go home with that question decided. There are good points on both sides of the question, and neither method of treatment is positive assurance against extension of the disease.

DR. LUND (*closing*). I have not been asked any direct questions, and do not know how the other men will answer, but in regard to the last subject that was brought up by Dr. Norsworthy, cleaning up the mouth, I agree that this is important and that we in Boston have paid too little attention to it. In the lip cases I think we do not pay attention to it at all, but in the mouth cases we have done so.

Preoperative roentgen therapy was not given in the cases I reported, and is still not being given at the Huntington Memorial Hospital in all the lip cases. It is in the mouth cases.

Dr. Lenz mentioned the palpability of the glands. That is open to discussion. If you place the fingers of one hand inside the mouth and part of the other outside there are very few individuals in whom you cannot feel normal glands. I do not know in speaking of palpable glands whether it is meant that they are normal or enlarged by infection or disease. I divide my cases for that reason so that we can say that in the group with enlarged glands of 1 cm. and over the glands probably have cancer cells in them.

To show the method of this study, during the last two days before I left Boston I had worked out in 147 cases a comparison of the five, four, three, two and one year end-results. With the surgical cases there was a surprisingly close

correlation with the one year to what we had at the end of five. That of the radium treated cases was not so good because we were using entirely inadequate irradiation, only enough to hold them in check for three to five years. That report will be published and I hope will be useful to those who are not able to get five-year results, and also to us who are using five-year results as a preliminary test, for it is hard to wait five years when the world is going ahead as fast as this symposium shows it is.

DR. MATTICK (*closing*). I think the question is still debatable as to the best methods of treating the primary lesions, either good surgery or good radiation seems perfectly feasible, whichever happens to be the best available. When it comes to the metastatic lesions, whether metastatic presumably or proved, there it seems we need a combination of good surgery and good irradiation. This latter group is the stumbling block it seems at present.

In the inoperable group where we get palliation only, I think the radiologists should refuse to treat the bad results of the surgeon, for he cannot get anything but palliation and that puts irradiation in an unfavorable light. I want to emphasize that dependency for causing regression in metastases cannot be placed on external irradiation alone. I do not wish you to think of one case I showed this afternoon as being the rule of roentgen therapy in this respect. With the radium pack we might get a little better results, but I doubt if any real increase in our five year cures.

Someone brought up the question of the expectancy of metastases in these cases. We have figured about 20 per cent of our apparently primary cases develop metastases later. I think Bloodgood shows 36 per cent when the glands were subjected to pathologic examination.

DR. WANGENSTEEN (*closing*). This has been an instructive symposium and I am grateful for the opportunity of taking part in it. I rather suspect that Dr. Lee's invitation to participate in the program was not extended without motive. Undoubtedly he realized full well the coercive persuasion of superior results obtained by methods other than those which we are individually employing.

From what I have seen and heard here today I am fully persuaded that the local lesion on the lip (after obtaining a small sliver of tissue for microscopic examination) is best treated with irradiation. From what I have heard I am not convinced, however, that the conservative plan

of dealing with the lymph nodes in cancer of the lip is the best. Those who advocate this plan are asking us to give up a plan of established and proved worth for another method of questioned equal merit. If they asked us to give up dealing surgically with the lymph nodes in cancer of the tongue, there would be far more logic in their contention, in that the results in cancer of the tongue when compared with cancer of the lip are poor, no matter what the method of treatment employed. For the patients that we see with cancer of the lip at the Cancer Institute at the University of Minnesota, I am persuaded that excision of the submaxillary and submental lymph nodes offers them more protection than irradiation.

In judging of the presence or absence of lymph node involvement, we know that the microscope is not infallible. It is true that in a large number of instances in which the regional lymph nodes are excised in cancer of the lip metastatic involvement fails of demonstration. How many of these, however, with complete eradication of the local lesion would subsequently have developed manifest metastases in the regional lymph nodes later had they not been previously dealt with? I wish to emphasize again the superiority of the biologic method (the lapse of time) over the microscopic in judging of metastatic deposits.

As far as the cause of cancer is concerned, we

still know exceedingly little about it. As one of the speakers stated, it is commendable to clean up the mouth in all instances. Dr. Alton Ochsner informs me that oral cancer is rather infrequent in colored patients in whom syphilis is rather commonly found.

With the intense interest exhibited in cancer investigation from many methods of approach, one cannot escape the impression that something fundamental will soon be forthcoming to guide us in treatment. Until then, however, it is necessary to continue in this empirical fashion.

DR. WEBSTER (*closing*). I wish to reiterate one point, that biopsy should be done to determine what the lesion is, for if you have no microscopic examination of the lesion it is difficult to say whether you have cured a cancer by radium or roentgen therapy.

Another point is that if all of the men who are treating epithelioma of the lip were members of this Society and were able to keep up with the rapid progress which you are making in radiation therapy it might be all right for them to use it, but scattered over the country there are countless men who are attempting to treat epitheliomata with insufficient amounts of radium or current, or without adequate training, and as a result we are getting many recurrences. They are far behind you here and they cannot treat lesions successfully, as you can with your modern methods and equipment.



THE ROENTGEN TREATMENT OF BRONCHIOGENIC CARCINOMA*

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THE increasing frequency with which malignant disease of the tracheobronchial tree has been recognized in the last few years is doubtless due to the increasing use of the bronchoscope in the differential diagnosis of pulmonary lesions, coupled with an increase in the number of roentgenographic examinations of the thorax. The bronchoscopist has learned by experience to distinguish many different types of lesions of the tracheobronchial tree, and also has learned the necessity of removing a piece of tissue for microscopic study from any lesion that appears to suggest a malignant process. By bronchoscopic and roentgenologic procedures it is now possible to recognize bronchiogenic carcinoma at a reasonably early stage. This improvement in diagnosis has brought with it the necessity and the indications for some method of palliative treatment.

Direct attack on the lesion by surgical diathermy through the bronchoscope is not advisable in most cases because the disease usually involves one of the main bronchi and extends beyond the limits of the bronchial wall. Since the lesion is usually more extensive than it appears through the bronchoscope, and smaller than the roentgenogram would lead one to infer, the technical difficulties of treatment through the bronchoscope are self-evident. A few surgeons have accomplished extirpation of bronchiogenic carcinoma, but because of the situation of the lesion and the difficulties of the operation, favorable results can hardly be expected in any large proportion of cases. Radium tubes may be applied directly to the lesion or imbedded in it, without undue difficulty, but the

radiosensitivity of the normal bronchial mucosa is still too little understood to permit the application of radium as a routine with impunity. For these reasons we prefer to use roentgen rays in the treatment of bronchiogenic carcinoma.

The technique of applying roentgen rays now in use in the Section on Therapeutic Radiology of The Mayo Clinic is the result of a slow and careful process of evolution, and has been developed chiefly from a clinical point of view. At the outset treatment was given with the utmost conservatism because of the fear, which subsequently proved to be groundless, of producing roentgen injury to the lungs and mediastinal structures, and because of failure properly to select cases for treatment. Encouraged by the demonstration that the lungs and mediastinal structures can tolerate doses of roentgen rays which are within the limits of tolerance for the skin, and because of a more thorough knowledge of pleuropulmonitis, resulting from the work of Groover, Christie and Merritt, Tyler and Blackman, Evans and Leucutia, and Desjardins, we now do not hesitate to treat many patients to whom irradiation was formerly denied.

Since tumors of the bronchi are usually about 10 cm. beneath the skin covering the anterior surface of the thorax, and are relatively resistant to irradiation, and since the average anteroposterior diameter of the right side of the thorax, in which the majority of carcinomas in our cases have occurred, is about 23 cm., it is evident that roentgen treatment must be carried out at high voltage, and that the principle of cross fire must be adopted in order to deliver an

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effective dose of roentgen rays to the lesion.

Even though the absorption characteristics of pulmonary tissue are at present imperfectly understood, our experience has shown that a four-field cross fire of the lesion, with one field through each hemithorax anteriorly and one through each hemithorax posteriorly, with the vertical beam directed toward the lesion, which usually lies 2 or 3 cm. from the sagittal plane of the thorax, is not only well tolerated by the average patient, but produces favorable clinical results.

Whether an increase in dose by application of radium in situ, as in carcinoma of the uterine cervix, may lead to better results is a problem which has not yet been sufficiently studied. On general principles, the danger of producing a radium effect in the bronchial wall is one that must be given serious consideration when planning the treatment.

With the facilities at our disposal the treatment of each field is carried out as follows: The roentgen rays are generated at 200 kilovolts and 5 milliamperes by a transformer with mechanical rectifier activating an air-cooled high-voltage Coolidge tube. The radiation emerging from a Failla drum tube-holding device is filtered through 0.75 mm. copper and 2 mm. aluminum. With this set-up, and at a target skin distance of 50 cm., the threshold erythema dose is produced in seventy minutes, and measured in air by the Victoreen dosimeter, equals 560 r. We have not had any experience with constant potential machines, nor have we tried any of the methods of protracted or fractional irradiation.

Because the tumor has been localized both by bronchoscopic and roentgenologic examination, administration of the necessary cross fire of the region is facilitated. Extreme care is used in arranging the patient and the roentgen tube to insure the correct direction of the vertical beam into the lesion. To avoid any chance of missing the tumor, large fields are used, and each beam of roentgen rays is applied at an angle of about 45° from the vertical.

Since some patients are extremely uncomfortable from dyspnea and irritating cough, it is essential to minimize systemic reaction and to avoid fatigue by dividing the treatment into sessions of moderate duration. Most patients can tolerate complete irradiation of one of the four fields each day. In some cases it is necessary to divide the treatment for each field into two or more sessions. A complete course of treatment, therefore, may require from four days to two weeks, depending on the patient's condition and ability to tolerate irradiation. Nausea and vomiting are seldom severe enough to require care, and are reduced to a minimum by the patient's abstinence from food for three hours before and after treatment. No remedy which we have tried has been efficacious in preventing or treating gastrointestinal reaction. After the four fields have been treated, some changes in blood pressure or destruction of the elements in the blood may occur, but have never been sufficient to cause any concern.

Shortly after cessation of the immediate reaction to the rays, most patients notice increased expectoration, sometimes of frankly purulent material, and subsidence of fever, followed in a few days by decrease of coughing, pain, and dyspnea. In all probability these effects are due to the action of roentgen rays on the inflammatory infiltrate surrounding the lesion, and on the mucus-producing glands of the bronchi. The radiosensitivity of these structures has been established by abundant clinical and laboratory experiments.

In about two weeks regression of the tumor begins, and the symptoms abate as regression proceeds. When these changes are slight, the dose effective in the tumor was too low. Improvement reaches its height about a month after treatment, and has almost run its course by the end of the sixth week. We feel, therefore, that symptomatic improvement, even if slight, indicates repetition of treatment, as it is almost invariably accompanied by organic improvement in the malignant process.

The technique of the second course of treatment, given about six weeks after the first, although essentially similar to the first course, is modified to suit the new data obtained by bronchoscopic and roentgenologic examination. If indicated, the second course is followed by a third course of roentgen treatment after two months.

From May 1, 1925, to January 1, 1931, at the clinic, diagnosis of primary malignant disease of the tracheobronchial tree was made in 71 cases by removal of tissue from the lesions in the bronchus through a bronchoscope. We have been able to keep in close touch with all of these patients, and the results obtained have been reported in detail elsewhere.

Sixty-one of the patients are dead, and of this number 32 received treatment at the clinic or at home. Those who received treatment lived from two weeks to four years after returning home; the average duration of life was slightly more than eight months.

The 29 untreated patients lived from a few days to thirty-one months after a positive diagnosis had been made, or an average of a little more than five months. This difference in the duration of life, with and without treatment, may have been due partly to the fact that certain of the latter group were not treated because of complications that made irradiation inadvisable. However, in most cases treatment was offered to patients regardless of the existence of pleural effusion or metastasis.

It is difficult, if not impossible, to determine the duration of symptoms of carcinoma of the bronchi, because of the possibility that, in many cases, pulmonary abscess or bronchiectasis may have antedated the malignant disease. In the cases in which treatment was given, however, the duration of pulmonary symptoms was approximately the same as in the cases in which it was not given.

One patient had radon seeds implanted into the bronchial growth after he left the clinic; he lived for four years. Two patients observed since January, 1931, have been treated by implantation of radon seeds into the bronchial lesion, but neither showed

any evidence of beneficial effect. Ten patients who were treated only by high voltage roentgen rays are improved or are living and well from fifteen months to four years after treatment. Eight patients of this group received all treatment under our direction, and 2 were treated after returning home.

Even though the palliative results we have obtained in this group of cases are not brilliant, we feel that the employment of roentgen therapy wherever possible is justified, unless it is contraindicated by extensive metastasis or extreme weakness or cachexia.

SUMMARY

From May, 1925, to January, 1931, in 71 cases, primary carcinoma of the tracheobronchial tree was diagnosed by removal of tissue from the lesion through the bronchoscope. Twenty-nine patients did not receive treatment, and all of them are dead; the average duration of life was a little more than five months. Forty-two were treated with radium or roentgen rays, either under our direction or at their homes. Thirty-two of these lived for an average of eight months after a diagnosis had been made. Ten patients who received roentgen therapy alone are living from fifteen months to four years after malignant tissue had been removed from the lesions; the average duration of life has been twenty-three months.

REFERENCES

1. DESJARDINS, A. U. The reaction of the pleura and lungs to roentgen rays. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1926, 16, 444-448.
2. EVANS, W. A., and LEUCUTIA, T. Intrathoracic changes induced by heavy radiation. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1925, 13, 203.
3. GROVER, T. A., CHRISTIE, A. C., and MERRITT, E. A. Intrathoracic changes following roentgen treatment of breast carcinoma. *AM. J. ROENTGENOL.* 1923, 10, 471-476.
4. TYLER, A. F., and BLACKMAN, J. R. Effect of heavy radiation on the pleurae and lungs. *J. Radiol.*, 1922, 3, 469-475.
5. VINSON, P. P. Primary carcinoma of the bronchus. *Minnesota Med.*, 1932, 15, 15-17.
6. VINSON, P. P., and LEDDY, E. T. The roentgen treatment of primary malignant disease of the tracheobronchial tree. *Ann. Otol. Rhinol. & Laryngol.*, 1932, 41, 1259-1267.

DIAGNOSTIC VALUE OF CHEST ROENTGENOGRAMS PRODUCED WITH HIGHER POWER FACTORS*

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A STUDY of the opinions of fifty general and chest roentgenologists with an average experience of eleven years and from different parts of the United States and Canada on the diagnostic value of chest roentgenograms taken with milliamperes varying from 100 to 1,000, with kilovoltages from 50 to 85, at exposure times from $1/4$ to $1/120$ second and at target film distances from 5 to 9 feet, shows a preference for those roentgenograms taken at 1,000 milliamperes, $1/30$ to $1/40$ second exposure, 7 to 8 foot distance with a penetration sufficient to produce the correct density over the entire lung field.

These fifty roentgenologists came to Iola Sanatorium, where the work was done, in response to an invitation and for the sole purpose of studying the relative diagnostic value of the films. They were asked to inspect and grade varying numbers of these films—some studied five series of each of the four subjects under investigation, others thirty, and a few a hundred.

It was explained to them that the experiment was designed to show the relative diagnostic value of chest roentgenograms having diverse degrees of contrast and density with various exposure time values and taken at different target-film distances.

They were told that the experiment was one of several conducted by members of the Committee on X-ray Apparatus and Technique of the American Sanatorium Association, and that the manufacturer had loaned the apparatus to a member of this committee in order that the practical value of high power chest technique might be determined.

The machine used was of the single phase pulsating type with milliamperage and voltage available at a maximum of

1,000 milliamperes at 85 kv. p.; the power line was a 300,000 circular mil conductor leading 75 feet to a 50 kv. w. transformer; the tube had an elongated focus with a projected focal area of $14\frac{1}{2} \times 16\frac{1}{2}/64$ of an inch; the time switch was of the zero potential type; the screens were of speed quality, and the films ultraspeed. The patients were adults of both sexes with ages from twenty to fifty-five, most of them having pulmonary tuberculosis. Their chests measured from 6 to 12 inches and their chest expansion varied from 1 to 6 inches.

CONTRAST

One of the four subjects investigated was the effect of different degrees of contrast on the diagnostic value of chest roentgenograms. It was, of course, understood that the lower the penetration, the greater the resultant contrast or tissue differentiation, other factors being adjusted to maintain the desired density. It was further understood that to secure maximum tissue differentiation without increasing the exposure time and without sacrificing density, milliamperes had to be increased.

Accordingly a set of four roentgenograms were made of the chest of each of 100 patients. The milliamperes used in making each set were 1,000, 500, 250, and 100. The kilovoltages were varied at each milliamperage setting enough to produce comparable densities. Time and distance remained uniform so far as was practical.

The roentgenologists individually and on different days reviewed from five to thirty groups of these sets of four. They knew that the films on each patient varied in milliamperage from 100 to 1,000 but they saw no technical data that would indicate the milliamperage used. They selected the one of the four films of each

* Read at the Twenty-seventh Annual Meeting, American Sanatorium Association, Colorado Springs, Colorado, June 7, 1932.

patient which in their individual opinion showed the most from a diagnostic angle.

After making this selection they tried to place the remaining three films in the order of their diagnostic value.

The following is a tabulation of their choices:

First place was given to 80% of the 1,000 ma. films
 First place was given to 13% of the 500 ma. films
 First place was given to 6% of the 250 ma. films
 First place was given to 1% of the 100 ma. films
 Second place was given to 9% of the 1,000 ma. films
 Second place was given to 61% of the 500 ma. films
 Second place was given to 22% of the 250 ma. films
 Second place was given to 8% of the 100 ma. films
 Third place was given to 3% of the 1,000 ma. films
 Third place was given to 23% of the 500 ma. films
 Third place was given to 52% of the 250 ma. films
 Third place was given to 22% of the 100 ma. films
 Fourth place was given to 5% of the 1,000 ma. films
 Fourth place was given to 5% of the 500 ma. films
 Fourth place was given to 20% of the 250 ma. films
 Fourth place was given to 70% of the 100 ma. films

A survey of these choices shows that the percentage of preferences increases as the milliamperes increase. Other figures show that 45 per cent of the films were placed in the order of the milliamperes used in the exposures.

TIME

Another subject investigated was the effect of the time of exposure on the diagnostic quality of chest roentgenograms. This was done by asking each of the visiting roentgenologists to judge and grade the second group of roentgenograms.

This group consisted of five or six chest roentgenograms made on each of 30 patients at 1/120, 1/60, 1/30, 1/20, 1/10, and 1/4 second exposure times. A motor driven top on the upper left hand corner above each patient's shoulder recorded on the film the number of impulses in each

TABLE I
CHOICES IN TIME OF EXPOSURE EXPERIMENT
EXPRESSED IN PERCENTAGES

No.	1/120	1/60	1/30	1/20	1/10	1/4	No.	1/120	1/60	1/30	1/20	1/10	1/4
1	0	0	100	0	0	0	26	0	10	30	20	40	0
2	20	0	20	60	0	0	27	0	20	40	20	20	0
3	10	30	30	20	10	0	28	0	40	20	40	0	0
4	20	10	40	20	10	0	29	0	60	0	0	20	20
5	0	0	40	40	20	0	30	0	20	60	20	0	0
6	0	0	40	20	40	0	31	0	60	40	0	0	0
7	0	10	70	10	10	0	32	0	0	60	40	0	0
8	0	10	70	10	10	0	33	0	40	0	60	0	0
9	0	10	30	10	20	30	34	0	40	40	20	0	0
10	0	30	20	30	20	0	35	20	40	40	0	0	0
11	10	10	20	0	60	0	36	0	0	20	60	20	0
12	0	0	60	20	20	0	37	0	40	40	0	20	0
13	10	20	20	40	10	0	38	0	0	0	20	80	0
14	60	0	20	0	20	0	39	0	20	40	20	20	0
15	20	20	40	0	20	0	40	0	20	60	0	20	0
16	50	10	40	0	0	0	41	0	20	20	0	60	0
17	10	20	40	10	20	0	42	0	0	60	40	0	0
18	10	0	40	20	20	0	43	0	0	40	20	40	0
19	10	10	50	10	20	0	44	0	20	60	20	0	0
20	10	0	40	20	30	0	45	0	0	60	20	0	0
21	0	0	40	50	10	0	46	0	0	60	0	0	0
22	0	0	40	50	10	0	47	0	0	0	20	80	0
23	0	20	60	20	0	0	48	0	40	20	20	20	0
24	0	40	40	20	0	0	49	0	0	60	0	40	0
25	0	0	40	50	10	0	50	0	0	40	20	40	0
Time							1/120	1/60	1/30	1/20	1/10	1/4	
Totals							240	260	1,960	1,060	940	60	
Percentage							5	15	39	21	19	1	

fractional second exposure. This left no doubt as to what exposure time was used, but this record of the exposure time was kept out of sight during the study of the films.

The roentgenologists graded five to thirty sets of these roentgenograms. This they did by judging the value of each film diagnostically. They saw no technical data on any film, but they knew the exposure times varied from 1/120 or 1/60 to 1/4 second, that densities were kept as comparable as possible and that the target-film distance was the same throughout. After choosing the best diagnostic film, they were asked to arrange the films in the order of their exposure times basing their judgment upon evidence of motion.

Table I shows their choices.

These choices illustrate the diagnostic value of short times of exposure but they present no conclusive data as to how short the exposure must be to depict the least evidence of motion. For the present it may be stated that in the opinion of fifty roentgenologists the exposure time of chest roentgenograms should be 1/20 second or less.

DISTANCE

To learn of the influence of target-film distance in improving the diagnostic quality of chest roentgenograms, over one hundred films were exposed of different individuals at distances of from 3 to 12 feet. In making the exposures density, contrast, and time were kept as uniform as possible.

For this series, the milliamperage was changed to compensate for the variation

TABLE II
CHOICES IN THE TARGET-FILM DISTANCE EXPERIMENT
EXPRESSED IN PERCENTAGES

No.	9'	8'	7'	6'	5'	No.	9'	8'	7'	6'	5'
1	80	20	0	0	0	26	0	20	20	40	0
2	20	20	40	20	0	27	40	0	40	20	0
3	10	50	40	0	0	28	60	0	20	20	0
4	40	30	30	0	0	29	60	20	20	0	0
5	0	60	0	20	20	30	20	40	40	0	0
6	0	40	40	20	0	31	20	20	60	0	0
7	0	0	50	30	20	32	0	40	20	40	0
8	0	0	50	30	20	33	20	40	20	20	0
9	0	0	50	30	20	34	20	40	20	20	0
10	0	30	20	50	0	35	0	40	20	40	0
11	10	20	30	30	10	36	40	40	20	0	0
12	0	40	40	20	0	37	0	100	0	0	0
13	0	20	30	30	20	38	0	40	40	20	0
14	100	0	0	0	0	39	20	20	40	20	0
15	30	30	40	0	0	40	20	40	20	20	0
16	90	10	0	0	0	41	0	60	40	0	0
17	10	60	20	10	0	42	0	20	20	60	0
18	0	30	0	40	30	43	0	20	20	20	40
19	0	20	40	40	0	44	0	60	40	0	0
20	10	60	20	10	0	45	0	0	60	40	0
21	0	20	50	30	0	46	0	20	60	20	0
22	40	50	10	0	0	47	20	0	20	40	20
23	40	20	40	0	0	48	0	40	40	20	0
24	0	20	80	0	0	49	10	40	20	20	0
25	20	0	40	40	0	50	20	20	40	20	0
Distance						9'	8'	7'	6'	5'	
Totals						870	1,430	1,470	950	200	
Percentages						18	29	30	19	4	

in distance—the penetration and time of exposure remaining constant.

The roentgenologists graded five to thirty sets of these films. They did not consider those taken at 3, 4, 10 and 12 feet. They saw no technical exposure data during the grading. They knew that the target-film distance of the five of each patient varied from 5 to 9 feet, that they were to select the roentgenogram of each patient giving the most useful information from a diagnostic standpoint and that they were to try to arrange the films of each patient in proper order basing their judgment on sharpness of detail, a function of distance.

Their choices as reflected in Table II show that they saw a higher diagnostic quality in films taken at 7 and 8 feet (59 per cent), and the least diagnostic value in those at 5 feet; that they had considerable difficulty in differentiating between films taken at 7, 8, and 9 feet, and finally that to some of them a decrease or increase in target-film distance of 1 foot produces perceptible changes in sharpness of detail.

DENSITY

Density presented a more difficult problem. The degree of general lightness or darkness or density preferred by roentgenologists varies within wide limits. Yet the density of a chest film can be too dark or too light. Both extreme density and lack of density handicap diagnosis by diminishing the visibility of detail and, if too extreme, by blotting out all detail.

The problem of determining the appropriate density was met by making two series of eight roentgenograms each on the same patient, one series with 100 milliamperes at 6 foot target-film distance in 1/10 second with density varying about 100 per cent in gradations of about 12.5 per cent and the other series of eight with 1,000 milliamperes at 7 foot distance, in 1/30 second with density varying about 80 per cent in gradations of about 10 per cent.

The roentgenologists individually and separately selected from each series of eight the exposure that in their opinion pro-

vided the most useful information from a diagnostic angle. They also indicated what films in each series they thought too light or too dark. Their choices were as follows:

TABLE III
CHOICES IN THE DENSITY EXPERIMENT

1000 ma.	100 ma.	1000 ma.	100 ma.
65	78	75	85
67	78	65	75
72	85	70	76
70	85	70	82
70	78	65	78
67	85	67	87
67	80	72	82
67	80	70	78
70	82	70	85
72	80	67	80
62	78	65	80
67	80	70	80
67	80	72	87
70	80	67	80
67	85	67	78
65	80	65	78
67	82	72	80
67	78	70	85
62	78	65	72
65	82	67	78
75	85	70	80
65	80	65	80
72	85	75	87
67	80	65	78
67	82	65	78
<hr/>			
Milliamperes	1,000	100	
Totals	3,403	4,045	
Kilovoltage	68	80	

The numbers represent the kilovoltage peak used in making what each roentgenologist considered as the best film diagnostically.

The films discarded by the group as unsatisfactory because of too little or too much density, when analyzed, showed that there is an allowable density variation of approximately 50 per cent, which means that for an average exposure of the whole chest there are four or five densities that are satisfactory and difficult to differentiate in quality.

CONCLUSIONS

The choices of fifty representative roentgenologists indicate that chest roentgeno-

grams taken with higher power factors have a diagnostic superiority over those taken with low power factors. These choices specifically indicate that:

1. Contrast produced by the lower voltages made possible through the use of 1,000 milliamperes helps make a better diagnostic film than the degree of contrast resulting at 500, 250, and 100 ma. with the increase in kilovoltage peak necessary to maintain the desired density at these current values.

2. Chest films taken in less than 1/10 or 1/20 second are better diagnostically than those with longer exposure times.

3. Target-film distance has a distinct influence on sharpness of detail, films exposed at 7 or 8 foot distance ranking highest.

4. On a single patient there are four or five exposures with different densities that are satisfactory to the majority of roentgenologists. However, it is possible to lose valuable detail by too much or too little density.



THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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For Preliminary Program of American Congress of Radiology: See April Number, AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY, page 539.

Date of Meeting: September 25-30, 1933.

Place of Meeting: Palmer House, Chicago Ill., Scientific Sessions, Scientific and Commercial Exhibits will all be held in this Hotel.

* For Officers and Standing Committees of the American Roentgen Ray Society and the American Radium Society usually carried on this page, see the April, 1933, number of the Journal.

† Combined meeting of: American Roentgen Ray Society, American Radium Society, American College of Radiology, Radiological Society of North America.

EDITORIALS

EFFICIENCY AND ECONOMY APPLIED TO THE ROENTGEN DEPARTMENT

IN ANY solution of the hospital problem means of promoting hospital efficiency and economy must not be at the sacrifice of ethical and fair consideration of the private practice of roentgenology. The hospital's economic scheme should not lean toward decreasing the fair and rightful profits of the physician. The loyal application of specialty training and consultation ability demands for its continuation a like loyalty from the hospital.

No beam of depression, economy or possible profit should obscure the vision of worthy service throughout years of an active professional life. Many of the attempts by hospital authorities to minimize, standardize, salaryize and level medical fees are serving to promote an unhealthy approach to the socialization of medicine which is inimical to productive individuality.

Many of the compromises of hospitalization schemes with the ethical and individualistic practice of medicine serve to detract from the reasonable rewards to physicians for loyalty, for studious application to professional attainment and may serve to segregate the time-honored teamwork of hospital and physicians.

The attitude of many hospital executives to look upon various medical activities as supplemental laboratory service or supplemental therapy or supplemental examinations rather than the actual practice of medicine will serve to estrange physicians practicing such specialties.

Far worse in the ultimate dangers of such conceptions of laboratory and mechanical measures is the fact that such interpretation of medical practice will serve to divert medical students to other channels of practice, and devitalize, perhaps

even kill and destroy, the progress and qualified application of otherwise attractive specialized departments of medicine.

Such conceptions of hospitalization progress and medical practice cannot continue parallel forever. The hospital cannot absorb functions of medical practice and escape the censure of time.

There must be compensation for studious application and a charm to the ultimate goal; otherwise, medical bench-sitters and switch-pullers will become mere automata or human robots. Nay, it would not be a distant development to add other minor medical specialties to this automatic, colorless, efficient, freedomless and mechanical scheme of the hospital organization.

It should be remembered that physicians preceded hospitals; that physicians can practice without hospitals but that hospitals cannot operate without physicians. The modern hospital executive with his experience and business ability should have a more sympathetic appreciation of the physician's problems. Business and professional effort can make a fine suspension but they rarely make a true solution of any problem.

No short-sighted approach to the economic demands of the present time should be allowed to prevail. There should be and there are methods of approach to the problem, and these proposed solutions are applicable in days of plenty as well as in these lean years. My proposals do not interfere with individual ambition and they serve to promote hospital economy and profit.

Salaries should not be given for professional effort; rather should there be a per-

centage basis of compensation and a sharing of proceeds. The former destroy ambition, while commission payment stimulates effort, promotes saving, provides for future progress, and advancement of happiness.

A hospital cannot hire physicians and escape the responsibility and accusation of pursuing medical practice. Hospitals cannot profit from the laboratory and other practice of physicians on a percentage basis and not be a party to a system of fee-splitting.

In many localities there are several hospitals, none of which may offer sufficient within their own walls to attract or pay for the full-time consultative service of a roentgenologist. With technical demands satisfied by a full-time technician, one roentgenologist may easily care for the diagnostic demands of at least four hospitals each day. Modern roads and rapid transportation make fifty mile trips as easy as any twenty-five blocks in street car days.

Technical service is easily established and economic possibilities are many. There is no reason why the technician in small hospitals could not easily serve both the roentgenologic and pathologic laboratories. Bookkeepers, record clerks and operating room nurses can easily become roentgen-ray technicians without sacrifice to either service.

Space-planning economies are many, and I believe that all laboratories and operating rooms should be compactly arranged on the same floor and in the same wing. This would aid in the cooperation of technical assistants, avoid many steps by many people, concentrate the staff in this working unit, develop contacts and increase the demands for laboratory examinations, and promote more consultation between attending physicians and laboratory consultants.

The cystoscopic room can be next door to the roentgen department and be served by a single roentgen-ray transformer. The fracture room can be next door and equipped with a fluoroscopic fracture unit.

The combined plate-viewing room and roentgenologist's office should be near the pathologist's office to afford that cooperative consultative service so beneficial to attending physician, surgeon and patient.

Economies in roentgen fees can be effected by securing the cooperation of the staff in asking for roentgenologic consultation for the particular diagnostic problem rather than a blanket demand for extensive and expensive technical procedures.

As to the nature of the request slips which come to the roentgenologist with cases, the clinicians could easily be induced to make more specific requests upon the clinical problem. One such case came with the legend, "Query, Chest"; the answer was returned, "Chest present, but feeble!"

Economies by cutting down the number and size of plates are rarely sane economies. The percentage saved is minimal and the loss to the patient may be great. Undoubtedly roentgenoscopic examinations by a roentgenologist can save many technical expenses. The cooperative roentgenoscopic consultation of clinician and roentgenologist can result in great saving and afford increased value to the patient and add to the hospital's reputation. Roentgenoscopic examinations are warranted in acute and chronic fluid and mass lesions of the chest and many gastrointestinal lesions affecting mobility and motility and gross filling defects. Stereoscopy should be carried out only when necessary.

Large films are expensive and their use can be reduced by intelligent cooperation of clinician and roentgenologist. Do not insist upon selling the patient roentgen films and disregard the advantages of thoughtful roentgen interpretation and intelligent, experienced roentgenoscopy.

Responsibility establishes worth and demands compensatory recompense. Service requires payment for basic expenses and sufficient pecuniary reward to compensate for intelligent direction, regular daily consultation service, satisfactory hospital records and reports, continuity of loyal serv-

ice and reward for ambitious extension and enlargement of that service to attending physician and patient.

However, economies must not be pursued which embarrass professional interest and activity. It should be remembered that 85 per cent of medical practice can be successfully pursued by intelligent clinicians

without laboratory, hospital, mechanical or modern methods. Common sense can easily eliminate much high-powered medicine but this is a rare mental commodity.

Modern mechanical medicine has replaced much medieval magic but the human mind can easily return to the charm of magic and mystery.

E. H. SKINNER



ROLAND E. LOUCKS

1869 - 1933

THE medical profession, particularly those engaged exclusively in roentgenology and radiotherapy, has lost a valuable and honored member in the death of Dr. Roland E. Loucks of Detroit who died at his home on June 8, 1933. Dr.

Loucks had been ill for about two years with cardiorenal disease but with the exception of about five or six months he had been able to carry on his practice. He was born at Smith's Falls, Ontario, on October 11, 1869. He was educated in the high school of his native province, after which he studied dentistry at the University of Maryland, from which he was graduated with the degree of D.D.S. in 1893, receiving the gold medal. He practiced dentistry for three years at Monroe, Michigan. He left Monroe to take postgraduate work in dentistry and in 1897 was awarded a dental degree by the Royal College of Dental Surgeons, Toronto, with registration in Ontario, after which he practiced in Smith's Falls, Ontario. Dr. Loucks, however, looked forward to a different professional career and accordingly began the study of medicine at Trinity and Toronto University from which he received the degree of M.D.C.M. in 1903. He located in Detroit the same year devoting his time to general practice.

In 1914 he began to give special attention to radium therapy after a prolonged period of postgraduate study in England, France and Germany.

In 1916, with a number of other enthusiasts, he was active in founding the American Radium Society of which he was president in 1922. He made numerous contributions to the medical literature on the use of radium in the treatment of goiter and in malignant conditions. Dr. Loucks always took an active interest in medical affairs

not only in his county society but also in the state, as well as in various societies devoted to his chosen specialty. During the summer of 1924 he visited a number of the larger radiological centers of Great Britain and the Continent. He was a member of the Wayne County and Michigan State Medical Societies, the American Medical Association, the American College of Radiology, the American Roentgen Ray Society, the American Radium Society, the Radiological Society of North America, Detroit Roentgen Ray and Radium Society, and the British Medical Association. He was founder and proprietor of the Memorial Hospital located in Detroit. Dr. Loucks' recreation included golf, lawn bowling and curling.

In 1898 Dr. Loucks married Miss Mary E. Dunlop. They had a son, Baden, and a daughter, Anna, who survive. Mrs. Loucks died in August, 1922. In 1926 Dr. Loucks married Mae B. Lyon who survives.

Dr. Loucks had an unusually pleasing and agreeable personality. Of distinguished appearance he was one long to be remembered as he appeared at the numerous professional assemblages. Schooled in sorrow, for the first Mrs. Loucks was for a long period an invalid and his daughter has been incapacitated for over twelve years, he had a warm feeling for all sufferers. Out of it all evolved a fine philosophy which not only sustained him but made him a close friend to all who came within his inner circle.

J. H. DEMPSTER

SOCIETY PROCEEDINGS CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.

Annual Meeting: Chicago, Ill., Sept. 25-30, 1933.

AMERICAN COLLEGE OF RADIOLOGY

Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.

Annual meeting: Chicago, Ill., Sept. 25-30, 1933.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.

Annual meeting: Milwaukee, Wis., June 12-16, 1933.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.

Annual meeting: Chicago, Ill., Sept. 25-30, 1933.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY

Secretary, Dr. D. R. MacColl, 2826 S. Hope St., Los Angeles, Calif.

Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. C. H. Hearcock, 20 S. Dunlap St., Memphis, Tenn.

Annual meeting: Richmond, Va., November, 1933.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N. Y.

Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.

Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. George M. Landau, 660 Groveland Park. Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. M. A. Thomas, Medical Arts Bldg. Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.

Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. L. M. Hilt, Myers Bldg., Springfield, Ill. Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. N. Collins, Indianapolis, Ind. Annual meeting each February 22 in Indianapolis.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Kalamazoo, Mich., October, 1933.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.

Meets first Friday in October, December, February and April. Place of meeting designated by the president.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.

Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. H. S. Bull, 604 Masonic Temple, Auburn, N. Y.

Three meetings a year—January, May and November.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Reiley, Clearfield, Penna.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. Karl Kornblum, 3400 Spruce St. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. W. W. Fray, Strong Memorial Hospital. Meets monthly on second Thursday from October, 1932, to May, 1933 inclusive, at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB

Secretary, Dr. W. K. Mueller, University Club Bldg. Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston, S. C.

Meets at time and place of South Carolina State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas. Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY

Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.

Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

VIRGINIA ROENTGEN RAY CLUB

Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.

Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA

Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba.

Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.

Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

INDIAN RADIOLOGICAL ASSOCIATION

Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta.

Meets annually in January, and at such places and times as the Council may appoint.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY

Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgium).

Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE

Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.

Secretary for German language, Dr. Scheurer, Molzgasse, Biel.

Meets annually in different cities.

SOCIÉTÉ FRANÇAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE

Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA

Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)

Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.

Permanent secretary, Professor Dr. Haensch, Klopstockstrasse 10, Hamburg, Germany.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY

Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETÀ ITALIANA RADIOLOGIA MEDICA

Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banul Maracine 30, Bucarest, Rumania.

Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson.

Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin.

Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY.

Secretaries, Drs. L. L. Holst, A. W. Ssamynin and S. T. Konobejevsky.

Meets monthly on the first Monday at 8 o'clock; the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. B. Krynski, 11 Zielna St.

Meets once a month except in the summer time.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN

Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY

Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK

Secretary, Dr. H. Scheuermann, Copenhagen.

Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND

Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY

Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION

c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY

Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan. Meets bi-monthly on third Sunday.

MINNESOTA RADIOLOGICAL SOCIETY

The annual meeting of the Minnesota Radiological Society was held in Rochester, Minnesota, May 22, 1933, in conjunction with the annual meeting of the Minnesota State Medical Association. The following program was presented:

Radiation Therapy in Non-malignant Conditions. Gage Clement, Duluth. Discussed by Wilhelm Stenstrom, Minneapolis.

Correlative Value of Clinical and Pathological Findings in Roentgenological Diagnosis. Kano Ikeda, St. Paul. Discussed by Charles G. Sutherland, Rochester.

The Place of the Roentgenologist in the Private Practice of Medicine. Leo G. Rigler, Minneapolis. Discussed by E. L. Tuohy, Duluth.

Childhood Tuberculosis. R. G. Allison, Minneapolis. Discussed by C. A. Stewart, Minneapolis.

Round Table Conference: Roentgen Diagnostic Problems. Conducted by B. R. Kirklin, Rochester.

The following officers were elected for the coming year: President: Edward Schons, St. Paul; Vice-President: R. G. Allison, Minneapolis; Secretary-Treasurer: L. G. Rigler, Minneapolis.



BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

A TEXTBOOK OF SURGERY. By John Homans, M.D., Assistant Professor of Surgery, Harvard Medical School. Second edition. Price, \$8.00. Pp. 1231, with 517 illustrations. With a special bibliographical index and with illustrations by Willard C. Shepard. Springfield, Illinois: Charles C Thomas, 1932.

The early need of a second edition of this textbook indicates that it has found popularity with the student of surgery. Minor changes have been made throughout the book in the interest of clarity and accuracy. A new chapter on anesthesia has been added in which the historical and physiological aspects of this subject are simply and clearly presented. All modern methods of anesthesia are considered in sufficient detail to have a practical value to the surgeon and are certainly ample for the needs of the medical student. New material has been interpolated and added to many chapters without change in the pagination, a matter of interest to teachers who have used the first edition.

The recent developments in the knowledge of the endocrine system, of interest to surgeons, have been adequately presented in this new edition. Hyperparathyroidism and its relation to skeletal disorders, hyperinsulinism due to adenomas of the pancreas, and Cushing's basophilism, are discussed briefly but at sufficient length for the medical student.

Two years' use of the first edition as a textbook for medical students has served to confirm and amplify the original favorable impression. The intimate informality of the style, the charm of the historical backgrounds and the vigor of presentation, grow upon one with continued use of the book. The second edition is an improvement in the omission of occasional errors, in the presentation of new material, and in rearrangement of certain obscurities. This edition, like the first, is highly recommended to any student of medicine and to any practitioner or surgeon who wishes to read with pleasure a concise presentation of modern surgical knowledge.

FREDERICK A. COLLIER

PEPTIC ULCER. By Jacob Buckstein, M.D., Instructor in Gastrointestinal Roentgenology, Cornell University Medical College (Annals of Roentgenology, Volume X.) Second edition, revised. Cloth. Price, \$12.00. Pp. 417, with 405 illustrations. New York: Paul B. Hoeber, Inc., 1933.

Objectives of this monograph, now newly revised, are set forth in prefaces respectively by the editor, the author and Dr. Santee. In sum it is designed to present a textual and pictorial roentgenologic survey of peptic ulcer, not merely in the interest of the roentgenologist but also that of the gastroenterologist, the internist and the surgeon. Considered from these diverse, though associated standpoints, with appreciation of the fact that it is impossible to convey complete understanding of the subject by printed word and illustration, the book fulfills its purposes. Illustrations preponderate so largely over text that the work constitutes an atlas, and thus conforms to the editor's plan for a series of monographic atlases of which this is one. Necessarily, then, the descriptive matter is sketchy and elementary. Even so, it covers the basic facts relating to the roentgenology of peptic ulcer—gastric, duodenal, gastrojejunal.

In the introductory chapter dealing with the history of the application of roentgen rays to the diagnosis of gastrointestinal disease, it is especially pleasing to note that the pioneer researches of Williams and Cannon and Hemmeter are accorded the place of honor. Likewise, the great contribution of Cole to the diagnosis of duodenal ulcer is given due recognition. These are timely reminders that in developing the roentgenology of the alimentary canal Americans have given a full share of effort and accomplishment.

Three-fourths of the book is devoted to case histories with positive prints of the respective roentgenograms. Most of the latter depict gross lesions, in situations where they are usually conspicuous, and of a type easy to illustrate. Thus it would be unfortunate if this work were regarded as confirming a too prevalent opinion among internists that the roentgenologic diag-

rosis is essentially pictorial and quite simple. But if properly used the volume should help students, clinicians, gastroenterologists and surgeons to understand the problems of the roentgenologist and should promote more effective cooperation of all those concerned with the discovery, identification and treatment of peptic ulcer.

B. R. KIRKLIN

LES KYSTES HYDATIQUE INTRATHORACIQUES CENTRAUX ET PARIÉTAUX; CHIRURGIE; RADIOLOGIE. Par R.-G. Brun, Ancien interne des Hôpitaux de Paris, Correspondent National de la Société de Chirurgie de Paris, Chirurgien Chef de l'Hôpital Sadiki de Tunis, et A. Jaubert de Beaujeu, Chef du Service Radiologique de l'Hôpital Sadiki et de l'Hôpital Civil Français de Tunis. Pp. 9, with 42 illustrations. Paris: Norbert Maloine, 1933.

Hydatid cyst of the lung is a rare condition to most roentgenologists but such is not the case with the authors, who see on an average of one patient with echinococcus infection every week. Approximately 80 per cent of the cysts occur in the liver but the remaining 20 per cent furnish the material for a relatively large experience in pulmonary cysts. Twenty-four cases are presented, including four with cysts in both lungs. The cases are illustrated by plates of good quality including both posteroanterior and lateral projections.

Both the diagnostic aspects and the surgical treatment are considered. Points of differentiation from infections of the abscess type and from neoplasms are discussed. The relative incidence of cysts as compared with neoplasm may be judged from the fact that the authors' experience of the past ten years in Tunis includes only two pulmonary sarcomas.

The authors differ with other writers as to the character of the shadow of hydatid cysts, those of their series presenting more sharp and smoothly curved borders than have been described by Belot and Peutenil.

This well-written monograph is both interesting and instructive.

E. WALTER HALL

THE PHYSIOLOGICAL EFFECTS OF RADIANT ENERGY. By Henry Laurens, Ph.D., Professor of Physiology in the Tulane University School of Medicine, New Orleans, La. American Chemical Society Monograph Series. Cloth. Price, \$6.00. Pp. 610, with 104 illus-

trations. New York: Chemical Catalog Company, 1933.

Many books on ultraviolet rays have been written, most of them being relatively limited in scope and their object being chiefly to set forth in simple manner the essential facts concerning ultraviolet and infra red rays for physicians who have little knowledge of radiant energy in general and who are not familiar with the physical aspects of the subject. Few books of outstanding merit have heretofore been published. Moreover, the literature has been crowded with statements, many of which rest on rather flimsy evidence.

Doctor Laurens' book comes to fill an important need by supplying rather complete information about the physiologic effects of radiant energy. It constitutes an elaborate and painstaking summary of all the experimental and clinical observations relating to ultraviolet and infra red rays and as such is extremely valuable. Its value may not be appreciated by the general practitioner who does not have time for extended reading, but it will be appreciated by every physician who really desires to inform himself concerning the effects of radiant energy on the body and how these effects are produced, as far as such information is available at the present time.

The book is divided into seventeen chapters, the first being a general introduction. The other chapters take up the physics of radiant energy, the effects on the skin, the effects on wounds and skin diseases, the effects on the eye, on the circulatory system, on the blood, on metabolism, on body temperature, respiration and blood reaction, on tuberculosis, on bacteria, toxins, antitoxins, proteins, ferments, on protodynamic or optical sensitization, and the mode of action on physiological and pathological processes. The book will be invaluable to the specialist and to all others as a mine of information which heretofore has been scattered and therefore often not accessible. In the opinion of the reviewer this is the most valuable book on ultraviolet and infra red rays which has yet appeared.

A. U. DESJARDINS

LA TECHNIQUE DE LA CURIÉTHÉRAPIE. (The technique of curie therapy.) Par Simone Laborde, Chef du service de Curie-thérapie à l'Institut du Cancer. Paper. Price, 20 fr. Pp. 118, with 12 illustrations. Paris: Gauthier-Villars et Cie, 1933.

This is one of a series of monographs published under the editorship of Duhem (Paris) dealing with those physical agents used in human therapy.

The author devotes the introduction to radiobiology presenting briefly the fundamental principles on which our modern cancer therapy is based. The applicators for beta and gamma irradiation are then described, followed by a discussion of the various techniques developed for their most effective use. Space is also given to the physics of dosimetry and the reader finds data and practical examples showing the calculation of the treatment time for certain screens and filters. A few minor errors may be detected here by the careful reader. In an appendix is found a number of tables, mostly giving physical constants of radioactive substances. The author, who is well known to radiologists attending the international congresses, has condensed a great deal of valuable information into small space.

ERNST A. PCHLE

BOOKS RECEIVED

INTRACRANIAL TUMORS. By Percival Bailey, Professor of Surgery, University of Chicago. Cloth. Price, \$6.00. Pp. 475, with 155 illustrations. Springfield, Illinois; Baltimore, Maryland: Charles C Thomas, 1933.

PEPTIC ULCER. By Jacob Buckstein, M.D. (Annals of Roentgenology, Volume X.) Second edition revised. Cloth. Price, \$12.00. Pp. 417, with 425 illus-

trations. New York: Paul B. Hoeber, Inc., 1933.

ROENTGENOGRAPHIC STUDIES OF THE URINARY SYSTEM. By William E. Lower, M.D., F.A.C.S., Chief of Department of Urology, Cleveland Clinic, Former Associate Professor of Genitourinary Surgery, Western Reserve University, Surgeon to Cleveland Clinic Hospital, and Bernard H. Nichols, M.D., F.A.C.R., Chief of Department of Roentgenology, Cleveland Clinic, Cleveland, Ohio. Cloth. Price, \$16.00. Pp. 812, with 812 illustrations. St. Louis: The C. V. Mosby Company, 1933.

RECENT ADVANCES IN RADIUM. By W. Roy Ward, M.B., B.S., M.R.C.S., Medical Director and Surgeon to the Radium Institute, London, and A. J. Burden Smith, M.B., B.S., M.R.C.S., Surgeon to the Radium Institute, London. Cloth. Price, \$5.00. Pp. 324, with 4 colored plates and 140 black and white illustrations. Philadelphia: P. Blakiston's Son & Co., Inc., 1933.

HUMAN CANCER: ETIOLOGICAL FACTORS; PRECANCEROUS LESIONS; GROWTH; SPREAD; SYMPTOMS; DIAGNOSIS; PROGNOSIS; PRINCIPLES OF TREATMENT. By Arthur Purdy Stout, M.D., Associate Professor of Surgery, College of Physicians and Surgeons, Columbia University; Attending Surgical Pathologist, Presbyterian Hospital, New York. Cloth. Price, \$10.00. Pp. 1007, with 331 illustrations. Philadelphia: Lea & Febiger, 1932.

THE PHYSIOLOGICAL EFFECTS OF RADIANT ENERGY. By Henry Laurens, Ph.D., Professor of Physiology in the Tulane University School of Medicine, New Orleans, La. American Chemical Society Monograph Series. Cloth. Price, \$6.00. Pp. 610, with 104 illustrations. New York: Chemical Catalog Company, 1933.



DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., 105 Rutledge Ave., Charleston, S. C.

A NEW METHOD OF ROENTGEN PELVIMETRY*

PRELIMINARY REPORT

By HOWARD C. MOLOY, M.D., M.Sc.

NEW YORK CITY

IN THIS preliminary report, an optical principle is reviewed and its practical application in the form of a workable apparatus for accurate measurement of the pelvis is described. The justification for suggesting a new method of roentgen pelvimetry is the belief that its simplicity may tend to aid in popularizing a refinement in obstetrical diagnosis of undoubted importance.

The possibility of measuring the image of a pelvis in space under stereoscopic vision suggested itself during the routine examination of roentgen films as part of an experimental study of the anatomical variations in the female pelvis. This work is still in progress at the Sloane Hospital for Women, and the Roentgen-Ray Department of the Presbyterian Hospital. It is being continued along the lines described in a preliminary report, in conjunction with Dr. W. E. Caldwell.³ We found that useful information, of greater importance than actual measurements, is gained by a study of the pelvis under stereoscopic vision. In many cases measurements are not essential, as one learns to judge amplexity in size and shape from examination of many stereoroentgenograms. But when measurements in whole, or in part, are desired, it was thought that it would be advantageous if the observer were equipped with a possible means of measuring the image in space while studying the architecture of the pelvis itself.

On further consideration it seemed logical that, under proper conditions, the image could be viewed in its true relation to

the original object, particularly in reference to size and shape. A review of the literature showed that this physical principle has been noted but apparently it is by no means well known by roentgenologists generally.

Wilsey⁸ very briefly and concisely describes this relationship. He states: "The stereoscopic image, obtained from stereoradiographs exposed and viewed under the proper conditions, is entirely free from distortion. The correct stereoscopic procedure re-constructs in space the radiographic representation of the subject in its true size and proportions" (Fig. 1). Further, Beck and Smith,² in their article on "The Physiology of a True Optical View by means of the Stereoscopic Radiograph," note that in the stereoscopic image all distortions can be corrected and a "true optical view" obtained. On this basis a new instrument has been devised whereby the size of an unknown object can be ascertained by measurement of the true optical image of the object under stereoscopic vision.

The application of this physical principle in the form of an instrument necessitates certain changes in the method of taking stereoroentgenograms. Concerning the stereoscope itself slight changes are necessary in the viewing boxes and in the optical system. The image is measured directly in space under stereoscopic vision by the use of movable armatures equipped with points which can be placed on any bony or object prominence.

The working of the instrument and the manner in which all conditions are satisfied

* From the Department of Obstetrics and Gynecology, Columbia University and the Sloane Hospital for Women, New York.

for reproducing an image the same size and shape as the original object, can be illustrated by describing the primary adjustments necessary to fulfill these requirements. When these have been satisfied absolutely no adjustments of viewing box or mirror stand are necessary for viewing and measuring succeeding routine films.

In this study a $2\frac{1}{2}$ inch target shift with a 25 inch tube distance, as recommended by Snook,⁶ has been used. A metal bar containing a perforation near either end is rou-

is fitted with two shallow pegs near the table border to correspond in size and position with the shadows of the perforations in the metal bar. These pegs are placed in the same relation to the geometric center of the viewing box as the metal bar is placed in relation to the cassette. The shadow points of the perforations in the metal bar are now punched out and the films are placed on the pegs in the viewing boxes. By these adjustments the films are assured a position in the viewing system of the stere-

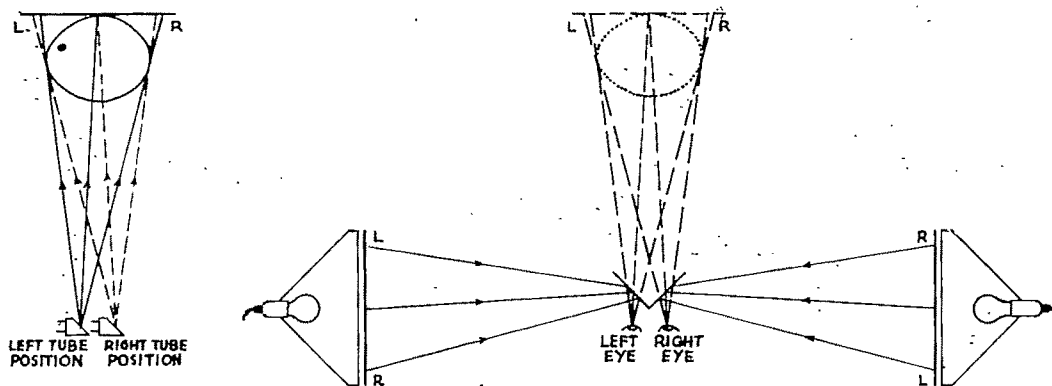


FIG. 1. "Left—Correct tube position for exposing stereofilms. Right—Correct method of viewing stereoradiographs in the Wheatstone stereoscope. Note the exact geometric correspondence between the conditions of exposing the films and the conditions of viewing the radiographs." (Wilsey.⁸)

tinely placed on the cassette. This marker is somewhat similar to the one described by Johnson.⁴ Care is exercised in placing the mid part of the bar opposite the geometric center of the film and along the film edge (Fig. 2). Theoretically this bar may be placed on any part of the cassette. However, by fixing the marker in a central position along the film edge several advantages result. It cannot be dislodged during the technical procedure of exposure; it does not conflict with the shadow image; its position can be readily duplicated on the viewing box in geometrical alinement with the optical system of the stereoscope. The object to be measured is now placed on the roentgen table in any desired position, with or without a Potter-Bucky diaphragm, and the two exposures made.

In order to view the films correctly the stereoscope is modified. Each viewing box

oscope similar to the conditions under which they were exposed.

In order to permit the observer to view the armature tips and the image simultaneously, the silver mirror of the ordinary stereoscope is replaced by two pieces of plane glass or a system of prisms. The latter does away with the double image effect. The mirror stand is placed midway between the viewing boxes, the distance depending upon the original target film distance.

With the films in position it will be noted that a stereoscopic image of the object can be obtained by two maneuvers. With the mirror stand fixed, changing the angle of the mirrors to each other slowly superimposes the magnified shadow image until the third dimension is appreciated by the eye of the observer. Precisely the same effect can be obtained by fixing the mirrors at an

angle of 90° and moving the mirror support forward or backward. The second procedure is more desirable.

It is now necessary to fix the optical system of the stereoscope in alinement with the films in the viewing boxes. Difficulty is encountered in finding the proper point where stereoscopic vision occurs. The eyes

tween two points on the image corresponds with the distance between similar points on the known object. The optical system is anchored at this point. All succeeding films are viewed without a single adjustment of the instrument other than manipulation of the movable armatures in the actual measurement (Fig. 2).

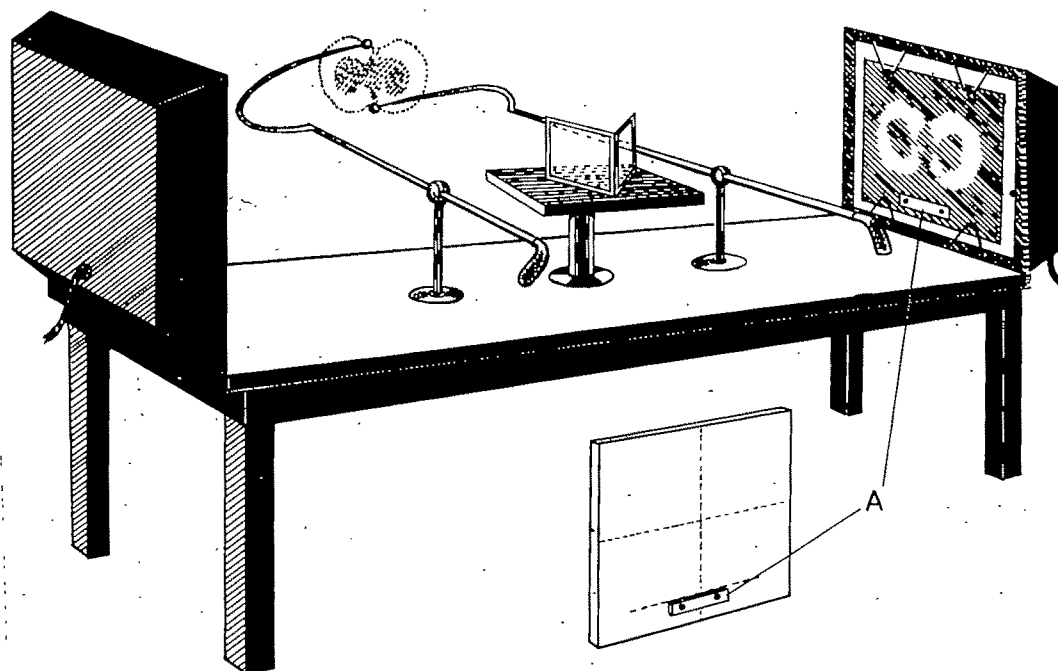


FIG. 2. Diagrammatic representation of the modified stereoscope. Note the fixed optical system of plane mirrors or prisms and the movable armatures for direct measurement of the image in space. Note, *A*, the relationship of the metal marker on the cassette to its shadow image in the roentgenogram on the pegs in the viewing box.

are not dependable as there is a natural tendency to create an apparent stereoscopic image before the roentgenograms are correctly superimposed. This difficulty is overcome by a trial and error method. Stereo-roentgenograms of a known object, as for instance a dried pelvis, are made using the technique of exposure just described. The shadow points of the perforations in the metal marker are punched out and the films placed on the pegs in the viewing boxes. The mirror stand is moved slowly forward or backward. The correct superimposition of the shadow image and necessarily the precise point of stereoscopic vision exists when the measured distance be-

If the conditions under which the original object was viewed by the target of the roentgen tube have been carefully duplicated in the stereoscope, the image represents a true optical view of the object. Determination of the distance between any two points in the image is made by placing the tips of the movable armatures on the points as they appear in space behind the mirror; the distance between the armature tips is measured directly by a ruler. Under stereoscopic vision the image may be likened to a frosted glass model of the original object. It may be considered optically difficult to measure such a structure by the use of pointers viewed as "real" objects through

the plane glass mirror or prism. Actual experience shows this is by no means a formidable difficulty. However, in order to decrease the contrast the armatures are designed to appear to the eye as having the same delicate texture as the image itself.

The effect of slight variations in individual interpupillary distances on the size of the image must be considered. This possibility appears to be of sufficient importance to warrant careful experimentation since accuracy, so far as measurements go, is desired. It seems highly probable that, if such variations affect the image size, compensatory adjustments of the apparatus can be made.

By means of an apparatus arranged as described above, accurate measurements can be obtained from dried pelves. The most difficult anatomical landmark to identify on the image is the sacral promontory. This point, as a rule, is more easily appreciated on the image from a living subject than from the dried pelvis, as a result of the varying densities of the surrounding tissues in the former. Therefore, equally accurate measurements can be obtained from living subjects but to date there have been few opportunities for checking such measurements.

Recently information concerning a new roentgen-ray stereoscope based on the sound physical principles described by Kurtz and Bridge⁵ has been obtained. This instrument is very similar to the modification described above except that the tube shift distance is dependent on the following formula: The shift equals the target-film distance divided by 9. "The viewing boxes move along ways inclined to the axis of the instrument on the horizontal plane, thus supplying the angle of the convergence necessary for natural vision."¹ Stereoscopic vision is automatic as the optical system is fixed in relation to the geometric center of the viewing boxes.

There is, therefore, a great similarity between the instrument devised by Kurtz and Bridge and the apparatus here described. It is hoped that further investigation, using a combination of the methods

discussed, may result in the development of a practical instrument equipped with armatures whereby measurements of a bony structure can be computed directly under stereoscopic vision.

Obviously with this method the position of the patient is of secondary importance. In the early months of pregnancy the semi-recumbent position of Thoms⁷ may be used. Later when the enlarged uterus tends to obscure bone detail the comfortable supine position is more advantageous. The usual care in placing the films in the viewing boxes in order to avoid pseudo-stereoscopic images must be exercised.

If time and experience prove the efficiency and practical usefulness of this instrument in roentgen pelvimetry undoubtedly it may be used to advantage wherever stereoscopic studies of a part are indicated.

Detailed results will be published later.

I wish to express my deep appreciation to Professor B. P. Watson, Director of Sloane Hospital for Women, for his interest and help throughout this work. This and further studies have been made, and are being continued in association with Dr. W. E. Caldwell, Assistant Director of Sloane Hospital for Women, and Dr. P. S. Swenson of the Roentgen-Ray Department of the Presbyterian Hospital. I am very grateful for the many valuable suggestions offered by Dr. Kenneth Cole of the Department of Physiology, Columbia University.

REFERENCES

1. BAUSCH and LOMB. A new development in x-ray stereoscopes.
2. BECK, E. G., and SMITH, ELLIOT. The physiology of a true optical view by means of the stereoscopic radiograph. *Radiology*, 1925, 5, 60-66.
3. CALDWELL, W. E., and MOLOY, H. C. Sexual variations in the pelvis. *Science*, 1932, 76, 37-40.
4. JOHNSON, C. R. Stereoroentgenometry; method for measurement by means of roentgen ray. *Am. J. Surg.*, 1930, 8, 151-163.
5. KURTZ, H. F., and BRIDGE, EZRA. A method of precision in stereoscopic roentgenography. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1927, 18, 370-377.
6. SNOOK, H. C. The practical use of the Wheatstone stereoscope. *AM. J. ROENTGENOL.*, 1919, 6, 39-47.
7. THOMS, HERBERT. Newly modified method for determining area of pelvic inlet by x-ray pelvimetry. *Am. J. Obst. & Gynec.*, 1925, 9, 667-672.
8. WILSEY, R. B. Stereoradiography and distortion. *Radiol. & Clin. Photography*, 1932, 8, 2-5.

PROTECTION CLAMP FOR THE TESTIS

By ARTHUR U. DESJARDINS, M.D.
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ROCHESTER, MINNESOTA

OFTEN when irradiating a tumor affecting one testis or a tumor around the lower part of the trunk or upper part of the thigh, it is essential to protect the testis from irradiation. In many cases this can be done by the simple expedient of covering the entire scrotum with lead-rubber or metallic lead, but in certain cases, in which it may be necessary to irradiate one testis or the major portion of the scrotum, the problem is how best to protect the opposite normal gland. In our work at The Mayo Clinic, we have accomplished this for a long time by means of a sheet of metallic lead, $\frac{1}{8}$ inch thick, with rounded corners and smooth edges. This was bent over so that two edges could be brought to-

gether, leaving an expanded space within which the testis was contained and by which it was protected. Useful and effective as this arrangement has been, it was only a makeshift. A more convenient apparatus was highly desirable and, to fill this need, I had made in our own workshop the clamp illustrated (Figs. 1 and 2).

The clamp consists of two relatively shallow valves, with an opening opposite the handles large enough to allow the soft tissues forming the pedicle to pass through. In applying the instrument, the scrotal tissues over the testis to be protected are slightly stretched so as to leave as much of the scrotum as possible outside of the clamp, but with the entire testis within the

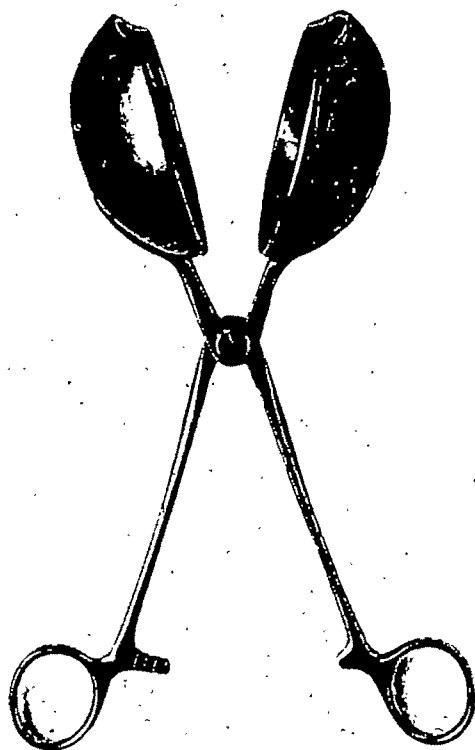


FIG. 1. Protection clamp open.

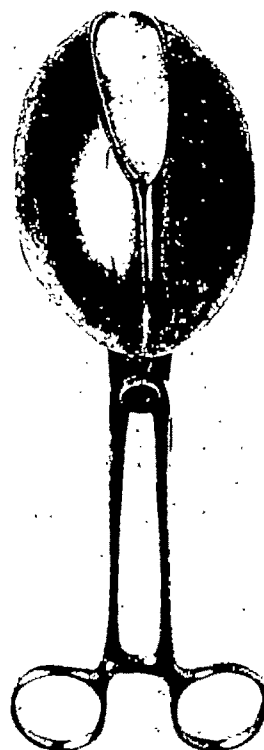


FIG. 2. Protection clamp closed and locked.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

ROGERS, LLOYD, HALL, C. TAYLOR, and SHACKELFORD, JOHN H. Fractures and incomplete dislocations of the mandible or maxilla. *Radiology*, Jan., 1932, 18, 28-40.

In 482 cases of fracture of the jaws, 94 per cent involved the mandible, the remainder the maxilla. Many fractures of the jaws are overlooked. In the authors' clinic all patients with head injuries are examined with the roentgen ray for the presence of jaw fractures. The principles employed in the treatment of fractures of the mandible and maxilla are: diagnosis from roentgenographic findings, reduction of the fracture, fixation of the parts, postoperative treatment, the use of exercising splints, and orthodontic appliances.

Removal of teeth and roots found in the line of fracture is not always advisable and, in many cases, is contraindicated. Sometimes the removal of these teeth is the cause of an osteomyelitis. Many of the retained teeth are extracted later. In gunshot fractures the removal of a foreign body is rarely warranted.

In describing the reduction of fractures, the subjects of occlusion, anesthetics, interdental wiring and postoperative care are discussed. The authors prefer the open reduction (intra-oral) for fractures of the mandible in which the teeth are not present. In treating children for fractured jaws the Barton bandage is used. There is also a discussion of incomplete dislocations of the jaw.—*Ellsworth Johnson*.

NECK AND CHEST

KWIET, BERNHARD. Die Änderung der Schattentiefe des Lungen-Röntgenbildes bei der Atmung. (The change of the shadow depth of the lung roentgen picture in respiration.) *Fortschr. a d. Geb. d. Röntgenstrahlen*, Jan., 1932, 45, 9-22.

Köhler, in 1907, introduced a procedure for the roentgen study of the respiratory excursion of the lungs which consisted in taking several roentgenograms at various phases of breathing and uniting them into one single "trick" film. Gött and Rosenthal, in 1912, made use of another

procedure, the so-called kymography, which, as is known, consists in intermittently moving a roentgen plate behind a lead screen provided with small slits through which the successive exposures are made. Both of these procedures proved unsatisfactory for the author's purpose and he therefore uses a third, the so-called grid procedure, which was recently introduced by Stumpf. Two exposures are made on the same film in the two phases of respiration (one in deep inspiration and the other in deep expiration), a grid arrangement being displaced in front of the cassette for the successive exposures. The grid consists of parallel iron rods of 0.3 cm. thickness and 0.5 cm. width, imbedded perpendicularly in a wooden frame. The distance between the rods is 0.5 cm. The displacement for the two exposures is exactly this distance so that the image of the thoracic structures in deep inspiration and expiration is obtained in the form of parallel stripes next each other. These stripes are then read with the aid of a densograph (from the bottom upward) and the inspiration and expiration curves plotted for various portions of the chest.

Certain precautions must be taken to insure that the exposure is made under exactly identical conditions. Thus the author simultaneously takes a control roentgenogram of an aluminum wedge on a small film which is fastened next to the regular roentgen cassette and from the two exposures he judges whether the amount of radiation used was the same. For the control of the position of the patient he uses a photographic camera, a lateral photograph of the patient being made during each exposure. The photographs so obtained are superimposed and the correctness of the position and the amount of respiration estimated.

The method is of value in diagnosing certain lesions of the apices which otherwise would escape detection and in studying the various types of respiration. It is admitted, however, that further improvements are necessary.—*T. Leucutia*.

HAUDEK, M. Durchwanderungspleuritis bei abdominalen Krankheitsprozessen. (Transmigration pleuritis in abdominal disease

processes.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1932, 45, 1-8.

The author, after making routine roentgen examinations of the chest in various abdominal conditions, found that certain secondary changes occur at the base of the lungs. They were observed chiefly in liver abscess, empyema of the gallbladder, free peritonitis, cirrhosis of the liver, pancreatitis, carcinoma of the transverse colon and in one case of unclassified peritoneal condition. The changes consisted, as a rule, in a slight haziness of the lower lung with distinct shadow formations, which had more or less sharp but irregular outlines running horizontally or obliquely, the picture being not unlike that of lymphogenic carcinosis. A mottled or patchy appearance of the shadows was never observed. The pleural sinus was often obliterated by a meniscus-like shadow or by a lamellar opacity along the thoracic wall. Large effusions were observed only in sub-diaphragmatic abscesses.

The above shadows were interpreted as being due to pleural changes, consisting chiefly of fibrinous deposits at the lung bases. The involvement of the diaphragmatic pleura and the diaphragm itself was evidenced by elevation of the leaf of the diaphragm and by a limited respiratory motion, which in the later stages were associated with slight irregularities of the diaphragmatic line. Seven case reports are briefly included and illustrated with several roentgenograms.—*T. Leucutia*.

DONZELOT, E., and ISELIN, MARC. Pleurésies interlobaires et abcès du poumon. (Interlobar pleuritis and abscess of the lung.) *Presse méd.*, Nov. 7, 1931, 39, 1625-1627.

Kourilsky, in his recent thesis, makes some quasi revolutionary statements concerning the relation of pulmonary abscess to interlobar pleurisy and especially the incidence of this latter. Thus he states (1) that interlobar pleurisy is very rare, there being only a few post-mortem observations in the literature; (2) that pulmonary suppuration is the rule, this being demonstrated in 9 out of 10 cases with uncertain diagnosis, and (3) that he personally has not observed one single case of authentic interlobar pleurisy.

The authors were able to study a case of abscess of the lung which had produced an interlobar effusion. After postural drainage of the abscess, the pleural effusion entirely dis-

appeared, but the abscess persisted for several months. Finally a complete healing ensued. Thus this case proves that the collection of the interlobar effusion was secondary to the abscess, there being an intimate relation between the two conditions.—*T. Leucutia*.

CHÉRON, A. Radiographie stéréoscopique du thorax de profil chez l'enfant. (Stereoscopic roentgenography of the infant thorax in profile.) *J. de radiol. et d'électrol.*, Aug., 1931, 15, 455-456.

Lateral stereoscopic roentgenograms of the chest in children are of certain diagnostic value in permitting a spatial estimation of the left and right hilus as well as of the shadows belonging to the roots of the lungs. The right inferior lobe which in the posteroanterior view is obscured by the dome of the diaphragm is particularly well visualized.—*T. Leucutia*.

KERLEY, PETER. Congenital diseases of the lungs. *Brit. J. Radiol.*, March, 1932, 5, 234-240.

Congenital lesions of the lungs are not infrequent but they cannot be diagnosed except by roentgen examination. Especially two groups are of great importance: the so-called azygos lobe, and the anomaly of lobe formation or, more properly speaking, of the bronchial architecture. In connection with this latter the author states that there is a definite and persistent tendency in man for the formation of a fourth lobe in the right lung and a less marked tendency for the formation of a third lobe in the left lung. The fourth lobe in the right lung is present in all quadrupeds and is well developed in the higher apes. Its persistence in the primates should have led us to suspect its frequency in man for we still have a long way to evolve before we discard all anatomical traces of our simian ancestry. Schaffner found a well-developed fourth lobe in the right lung in 15 per cent of normal individuals and a third lobe in the left lung in a slightly smaller percentage. In no less than 40 per cent of normal individuals evidence of accessory lobes can be found in a furrow running across the lower part of the lower lobes. The roentgen appearances of the collapsed accessory lobe are characteristic. With increasing deflation the lobe slowly becomes more opaque, its outer border becomes denser and straighter and eventually the whole lobe sinks into the paravertebral groove,

where it appears through the heart shadow as a triangular opacity. In a majority of cases bronchiectatic dilatation takes place in the collapsed lobe and infection sooner or later follows this dilatation. Up to the present many of the accessory lobes have been diagnosed as collapsed lower lobes and the collapse attributed to bronchiectasis.

In discussing the importance of bronchiectatic dilatation of the collapsed accessory lobe the author states that he found that of 60 children, proved cases of bronchiectasis seen at the Royal Chest Hospital, half of them lacked the typical symptoms of bronchiectasis such as cough, expectoration, general debility, toxemia. Therefore he believes that the old theory that infection plays a dominating part in the causation of infantile bronchiectasis must be discarded and that it must be assumed that they are rather on a congenital basis. This is supported also by the fact that at least 60 per cent of the children showed other congenital abnormalities of the bony thorax. If the idea of a congenital lobar origin of bronchiectasis is correct there is only one rational method of treating bronchiectasis with lobar collapse and that is removal of the lobe.—*T. Leucutia*.

WEYMULLER, CHARLES A., BELL, A. L. L., and TRIVILINO, A. A. Roentgenographic changes in the thorax of normal premature babies. *Am. J. Dis. Child.*, March, 1930, 43, 585-593.

In a previous communication the authors demonstrated the usefulness of a series of roentgenograms taken daily of normal infants during the first fourteen days of life. Since one frequently meets puzzling situations in premature babies, such as unexplained cyanosis, or cyanotic attacks, disturbances of respiratory rates or rhythm, or possible pneumonia of the new-born, the authors concluded that a study of premature infants was especially desirable. These occur even more frequently in premature infants than in normal. No previous control has apparently been reported.

Daily bedside roentgenograms of the thorax of normal premature infants for the first fourteen days of life were made. If there was cyanosis, feeble cry, dyspnea, excessive loss of weight or any other symptom suggestive of abnormality, the films were excluded from the series. Fifteen completely controlled cases were studied, a series of fourteen films for each being

made. A portable bedside unit was used, without removing the infant from the incubator. The following factors were employed: 88 peak kv., 30 ma., and a 25 inch target film distance. The patient was placed in the supine position, and an attempt was made to make the films at the height of inspiration.

In general, the lung fields were much clearer than those of the full term infants. There was a characteristic delicacy of structure of all the lung markings in the premature infants, and in 8 of the series this delicacy of structure produced strikingly diminished densities of the lung fields. Whereas most of the full term infants showed increased hilar and peribronchial markings on the first and second days with a gradual tapering off, this was true of but 3 of 15 premature infants. Furthermore, there was so little change from day to day in the premature series that practically any film might have been chosen as characteristic. The authors assume that the decreased density and more delicate structure of the peribronchial trunks observed in premature babies is accounted for by the relatively smaller size of the blood vessels.

In only one child was the interlobar line between the right upper and middle lobes demonstrable. This line was found quite regularly in normal, full term infants, and it varied with position. This one patient was of large size and weight, 2,200 gm., and it is suggested that there may be a weight level beyond which this common finding for larger babies may be found. Weight may possibly determine the density of these tissues.

Most of the full term infants showed definitely larger cardiac shadows on the first and second days. The size of the shadow diminished and became fairly constant in size after the third day. This was true in general of the premature infants studied, although the changes in size were much less striking. When there was decided enlargement (6 cases) during the first three days, the fullness was most marked at the left border. In one case the examination was especially useful. There was definite alteration in the shape of the right side of the heart, in addition to the enlargement common on the first day, as manifested by the enlargement of the right atrial region. At this time no murmurs were heard although they were sought particularly. This fullness persisted and on the fourteenth day a definite systolic murmur trans-

mitted to the vessels of the neck was heard over the region of the pulmonic second sound. From this case, the conclusion is drawn that evidence of congenital heart lesions is not always present on initial examinations and that potentially serious lesions can be overlooked, unless repeated clinical observations and roentgenographic studies are made.

There was variation of the mediastinal shadow in but one infant, in contrast with the decided variation in those of full term infants. Since respiratory excursion is so slight in premature infants the reason for the lack of variation in mediastinal shadow is clear.—*R. S. Bromer.*

ALTSCHUL, W. The hilus of the lung in the child. *Radiology*, Dec., 1931, 17, 1147-1152.

The boundary between the normal and pathologic hilus is indistinct. There is no really normal adult hilus. In children increases in size and density are found which in the absence of clinical symptoms cannot be regarded as pathologic. The author reviewed several thousand chests in an attempt to see when involvement of the bronchial glands can be assumed and when such involvement can be excluded. Since the involved glands may be located in widely different parts of the hilus, routine measurement at any time is of little assistance. Since glandular enlargement is usually localized corresponding to the site of the exciting parenchymal lesion, a uniform expansion points to circulatory stasis. Enlarged glands may be described certainly when the rounded outer borders of the individual glands can be seen. Pulmonary infiltrations are usually separated from the hilus and are not so sharply demarcated. Questionable enlargement should be evaluated through comparison with the glands of the opposite side. The interfering heart shadow may be avoided by slightly rotating the patient. Inequality of the two shadows is decisive for the diagnosis. In acute cases the existing focus in the lung is usually visible, later it may show as strands running from the focus toward the hilus. The activity of the lesion cannot be evaluated because often old fibrotic calcified glands contain active areas. Generally, however, when glands in children heal clinically, they regress to normal size; when the primary complex is visible the tuberculous nature of the lesion can be ascertained. Other causes of enlargement as pertussis or

influenza are extremely rare. Since certain groups of glands fall within the mediastinal shadow unless greatly enlarged, a negative roentgenogram does not rule out this enlargement.—*E. I. L. Cilley.*

STEWART, CHESTER A. Pulmonary diseases: 5,816 cases in children; with special reference to the childhood type of pulmonary tuberculosis. *Am. J. Dis. Child.*, April, 1932, 43, 803-827.

Stewart quotes the definition of the childhood type of pulmonary tuberculosis adopted by the American Sanatorium Association, 1929, namely, the diffuse and focal lesions in the lungs and adjacent tracheobronchial nodes that result from the first infection of the pulmonary tissue by the tubercle bacillus. His report is based on a study of 5,816 children, including 3,981 (68.4 per cent) and 1,835 (31.6 per cent) children having negative and positive Pirquet tests, respectively. In 1,179 children, or 20.3 per cent of the entire group of 5,816 persons, intrathoracic disease was revealed by roentgen examination. The prevailing type of lesions found in these 1,179 children was that produced by the *Mycobacterium tuberculosis*, as shown by the fact that childhood tuberculosis was found in 82.3 per cent (970 instances) of these cases. In summarizing the value of the various methods of detection of the disease, Stewart states that if a value of 100 per cent is assigned to the Pirquet test as measuring its efficiency in the discovery of childhood tuberculosis, the roentgen examination has a reliable efficiency of about 25 per cent, and the physical examination an efficiency of a small fraction of 1 per cent.

Resolving parenchymal tuberculous lesions of first infection (epituberculosis?) were found exclusively in the cases with positive tuberculin tests, constituting about 3.6 per cent (66 cases) of his group. With advancing age, the percentage yearly frequency with which resolving parenchymal lesions were found increased to a maximum of 22.2 per cent in the second year of life, but thereafter tended generally toward a progressive annual decline, and were rarely found after the eleventh year.

Questionable calcifications of the intrathoracic lymph nodes were reported in 1.5 per cent (59 cases) of the 3,981 children whose Pirquet test was negative and in 5.1 per cent (94 cases) of the 1,835 children whose tuber-

culin test was positive. Slight calcifications of these glands were reported in 1.8 per cent (72 cases) of the group with negative tuberculin tests and in 13.5 per cent (247 cases) of the group with positive tests.

Moderate degrees of calcification of the lymph nodes at the root of the lungs were rarely reported (4 cases only) in the 3,981 children with negative Pirquet tests, which for these cases was an incidence of only 0.1 per cent as compared with an incidence of 6.05 per cent (111 cases) for those with a positive tuberculin test.

Marked calcifications of the hilus glands were found less often relatively than the other degrees of calcification previously mentioned, in both the group in which the tuberculin test was negative, and that in which it was positive, being reported in only 0.025 and 1.04 per cent of each group respectively.

Ghon tubercles were discovered in 0.45 per cent (18 children) of the group with a negative Pirquet test, and in 15.2 per cent (279 cases) of those with a positive tuberculin test. The degree of intrathoracic glandular calcification accompanying Ghon tubercles varied from questionable to marked, with the moderate and marked degrees of calcification predominating.

From the standpoint of the appearance of lesions discovered by roentgen examination, childhood pulmonary tuberculosis of first infection is divided into the following three types by Stewart: (1) resolving pneumonic-appearing parenchymal consolidations, which represent early stages of the disease; (2) intrathoracic glandular calcifications of various degrees, which represent late permanent stages of the disease; (3) Ghon tubercles associated with hilar gland calcifications, which represent late and permanent stages of the disease. These various types of lesions merely represent various developmental stages in the evolution of the disease produced by a primary tuberculous infection, between which transitional stages may be noted. The end-result in non-fatal cases is always the same in that calcification of the hilus glands appears, or that Ghon tubercles develop, associated with calcification of the homolateral hilus glands.

In 45 children unmistakable evidence was discovered of the recent development of lesions of the adult type of tuberculosis superimposed on, and postdating previously existing quies-

cent lesions of the childhood type. Pleural thickenings and effusions were found in only a small percentage of the groups with negative and positive Pirquet tests, but tended, however, to occur with greater frequency in infected than in uninfected children. There was no increase in the incidence of bronchiectasis, pneumonia or pneumothorax among children with a positive tuberculin test as compared with children with a negative Pirquet test. These conditions were found in only a small percentage of the entire group studied.

Stewart believes that slight or questionable calcification of the hilus glands often indicates the discovery of small quiescent tuberculous lesions and that conspicuous calcified deposits establish with great certainty the presence of tuberculosis at the site of calcification. The first infection by the tubercle bacillus produces an unmeasured beneficial immunity but, with it, an easily demonstrable allergy. Reinfection of the lungs of allergic subjects results in adult pulmonary tuberculosis.—*J. C. Rosen.*

WILLI, H. Röntgenbefunde bei Masernpneumonien. (Roentgen findings in measles pneumonia.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1932, 45, 34-39.

The study is based on an observation of 27 cases, 16 of which were diagnosed clinically as pneumonia, 5 as bronchiolitis, 2 as bronchiolitis and pneumonia, 2 as bronchitis and 2 without pulmonary findings. The conclusion is reached that there are two forms of pneumonia in measles: (a) the miliary and (b) the confluent lobular. The nearly routinely observed patches and stripes are the result of peribronchial infiltrations and are most probably specific; the larger their number, the more severe the prognosis.—*T. Leucutia.*

EDWARDS, A. TUDOR. Malignant disease of the lung. *Brit. M. J.*, Jan. 24, 1931, 1, 129-132.

In the lung, carcinoma appears to arise primarily in two situations, the bronchi and the parenchyma. Endothelioma is described. Sarcomata are rare and when they do occur are usually of the spindle cell type.

Diagnosis is made by roentgen examination, before and after induced pneumothorax, and introduction of lipiodol into the bronchi. Bronchoscopy and thoracoscopy are important diagnostic measures.

In growths obstructing the bronchus roent-

gen evidence of atelectasis is seen with displacement of the heart and mediastinum. A dense wedge-shaped area of increased density is observed with the base toward the periphery. Central growths in the parenchyma of the lung appear as an opaque shadow, sharply outlined and without evidence of surrounding pulmonary reaction, as is seen in infective conditions such as abscess. In a certain proportion of cases the center of the growth becomes necrotic and should infection spread in from the bronchi, an abscess surrounded by new growth will result. The author has seen 118 cases of primary malignancies of the lungs. The bronchial carcinomata spread to the mediastinal glands early and little therefore can be expected by surgical removal. The author has one patient upon whom he operated for the removal of a carcinoma arising from the bronchus of the left upper lobe, alive and symptom-free eight months after surgical removal.

Radium therapy of these inoperable bronchial carcinomata is considered. The methods discussed are: (1) Teletherapy, application at a distance of large doses (1 to 4 grams) in a bomb. In 6 patients so treated all died without even temporary improvement being observed. (2) External application of radium plaques on Columbia paste is considered of value only when the growth is near to or involves the chest wall. The author did not observe any permanent cures by this method of treatment but there was a definite relief of the pain in 3 cases in which the chest walls were involved. (3) Radon seeds. For growths in the main bronchi there are definite dangers of perforation into the mediastinum by haphazard insertion of seeds into the growth itself. The author has devised a silver tube which contains 8 radon seeds. This tube is introduced into the bronchus by means of a bronchoscope and left in place four days and then withdrawn by a thread which has been left attached to the tube. For central neoplasms and for those arising peripheral to the main bronchi, which are inoperable, the direct insertion of radon seeds through a thoracotomy would appear to be the method of choice.

Central growths, those arising from the parenchyma, are those which offer the most hope of surgical cure; these, however, are in the minority. Of 118 cases of primary lung malignancies seen by the author only 9 were in this category and of these only one is alive

and without symptoms twenty months after operation.

The author states that deep roentgen therapy has proved very disappointing for primary malignant lung tumors. Occasionally the rapidity of development of secondary deposits in the lungs is diminished by deep roentgen therapy.—*J. H. Vastine.*

SERGEANT, EMILE. Bronchiectasies abcédées, abcès bronchiectasiques et abcès bronchiectasiques. (Abscessed bronchiectasis, bronchiectasing abscesses and bronchiectatic abscesses.) *Presse méd.*, Feb. 20, 1932, 40, 273-276.

The knowledge of dilatation of the bronchi has undergone numerous changes during the last few years, thanks to the systematic application of roentgen study by means of lipiodol. Thus it has been found that dilatation of the bronchi is, as a rule, intimately associated with bronchopulmonary suppurations, abscesses, and pulmonary gangrene, and vice versa. This complex anatomo-clinical and evolutive syndrome induced American authors especially to differentiate a distinct morbid entity which is called bronchiectatic abscess. The observations gained during the past ten years by the author himself have convinced him that the entity is lacking in precision and therefore he proposes that the following three varieties be distinguished: (1) The abscessed bronchiectasis in which the abscess or the gangrenous focus of the lung develops in the form of a complication of a preëxisting bronchiectasis which may be (a) acute or subacute and (b) chronic. The first may occur in protracted acute bronchopneumonias, whereas the second is the result of the well-known classical picture of chronic dilatation of the bronchi. (2) Bronchiectasing abscess in which a more or less chronic gangrenous focus or abscess of the lung forms the preëxisting factor, the bronchiectasis developing secondarily as a result of the effect of the chronic sclerogenic bronchopneumonic process upon the adjacent zones of the pulmonary tissue. (3) The bronchiectatic abscess, in which abscess and bronchiectasis develop simultaneously and which consequently may be considered as an association of the two. This form manifests itself clinically as suppurating bronchopneumonia, mostly lobar in type, and ends, with a few exceptions which assume a chronic course, nearly always fatally.

In conclusion, the author also briefly considers the various therapeutic procedures, especially emphasizing the value of aspiratory bronchoscopy which is highly recommended.—*T. Leucutia.*

BAND, DAVID, and HALL, I. SIMSON. Post-operative massive collapse of the lung: A clinical and experimental study. *Brit. J. Surg.*, Jan., 1932, 19, 387-409.

The use of roentgen rays and closer clinical investigation have revealed an increasing number of cases of postoperative massive collapse of the lung. Illustrative cases are cited and the various theories of causation are discussed.

A series of animal experiments is described in which many of the conditions occurring during operation are produced with and without the introduction of gum acacia of varying degrees of viscosity into a main bronchus. From this work it is concluded that the experimental production of massive collapse requires: (1) intrabronchial content of definite viscosity (equal to 75 per cent gum acacia); (2) abolition of the cough reflex, and (3) limitation of the respiratory movement.

In an effort to prevent the occurrence of postoperative collapse, it is recommended that nembutal be substituted for morphine and atropine as preoperative medication and that the anesthetist become proficient in the use of carbon dioxide in maintaining deep regular breathing. The application of tight dressings to the chest, and the occurrence of abdominal distention should also be prevented when possible. Sedative drugs should be prescribed as sparingly as possible in order that the bronchial tree may have a chance to empty itself after operation.

The inhalation of 10 per cent carbon dioxide in oxygen at hourly intervals is of great value after collapse has actually occurred. When this method fails, bronchoscopic removal of the viscid substance from the bronchi must be resorted to.—*C. L. Martin.*

LAZEANU, E. Sur le diagnostic radiologique des abcès du poumon. (The roentgen diagnosis of pulmonary abscess.) *J. de radiol. et d'électrol.*, Nov., 1931, 15, 608-614.

The study is based on a total of 28 cases of pulmonary abscess observed in the medical clinic of Prof. Nanu-Muscel. In 19 of these the classical hydro-aerial image was found. In the

others the abscess was associated with a diffuse, more or less homogeneous opacity, occupying a part or the entire lobe. Successive examinations at short intervals often revealed the presence of a clearer space within the opacity, later leading to the hydro-aerial appearance. Sometimes a multiplicity of the hydro-aeration was observed, no doubt due to multiple abscesses. In other instances the process continued to remain diffuse, leading to an extensive suppuration. In these latter small multiple abscesses were found within nearly completely hepatized lung at the autopsy. In case of healing there was a gradual clearing up of the opacity, with formation of cicatricial, sclerotic tissue. In 2 instances a small cavity persisted, in spite of disappearance of all clinical symptoms, in the center of such sclerotic tissue.

The author emphasizes the fact that successive roentgen examinations are indispensable for the study of the evolution of an abscess. The differential diagnosis includes in the obscure forms, interlobar pleurisy, pulmonary gangrene, infected bronchial dilatations, and rarely cancer of the lung. Within certain limits the roentgen examination may be used also for the prognostic evaluation of the pulmonary abscess. Thus, if the lesion is localized and surrounded by a fibrotic capsule the prognosis is somewhat better, whereas if the infiltration shows a tendency to extend the prognosis becomes grave.—*T. Leucutia.*

HUDSON, WILLIAM A. Lung abscess. *Radiology*, Jan., 1932, 18, 1-22.

The first roentgenographic evidence of abscess formation is the appearance of an area of increased density in the region of the bronchial obstruction. The markings of the bronchi distal to the obstruction appear as radiating lines. Succeeding studies show extension until an entire lobe or more may be involved. The usual lung markings become obliterated; later, areas of decreased density may appear. It may be noted that at the most dependent portion of these areas the outline is horizontal.

Abscess cavities are rarely surrounded by recognizable capsules, but appear as defects within boundaries of uniform density. When cavities communicate with a bronchus, free access of air causes their fluid contents to assume a horizontal level. If the exact localization of the abscess is impossible from the plate, de-

pendence must be placed on the findings at endoscopic examination. The roentgenologist will be aided materially if he makes frequent roentgen examinations—a roentgenoscopic study should also be made.

Differential diagnosis.

Lobar pneumonia. A second plate at the end of twenty-four hours should serve to differentiate lobar pneumonia as the consolidation in lobar pneumonia is usually much more rapid in its development than in the lung abscess.

Massive and localized atelectasia have the characteristic findings of a narrow hemithorax, increased density of the involved portion of the lung, and the narrow interspaces with the displacement of the mediastinal contents toward the involved side, and the elevation of the diaphragm.

If empyema is located adjacent to the mediastinum there will be displacement of the mediastinal contents toward the good side, in contrast to no displacement of these structures, as in lung abscess.

A chronic lung abscess can be differentiated from chronic bronchiectasia by the use of lipiodol.

Roentgenologic aid in treatment is discussed and 19 case reports with 45 illustrations are given.—*Ellsworth Johnson.*

SCHATZKI, R. Die Beweglichkeit von Ösophagus und Magen innerhalb des Zwerchschlitzes beim alten Menschen. (The movability of the esophagus and stomach through the diaphragmatic hiatus in old people.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1932, 45, 177-187.

Åkerlund distinguishes three types of diaphragmatic hernia: (1) the congenital type with short esophagus; (2) the para-esophageal type in which the esophagus enters the abdomen opposite the hernial sac, and (3) the hiatus herniae in which the non-shortened esophagus lies within the hernial sac. The author examined 30 old individuals (23 men, 7 women) between the ages of sixty-five and eighty-three with regard to the possible occurrence of the third type. For this purpose he administered to the patients a thick barium sulphate mixture and examined them in various positions by trying to produce a herniation through increase of the abdominal pressure (chiefly by insufflation of the colon). In 14 cases a displacement of the stomach upwards

through the diaphragmatic hiatus was found by simply changing the position; in 8 others by increasing the abdominal pressure with insufflation of the colon and in the rest the findings remained negative. Thus in summarizing, it was found that in a total of 22 out of 30 cases, that is 73.3 per cent, a diaphragmatic herniation of the stomach could be produced, indicating that acquired herniae are a rather frequent occurrence in advanced age. This no doubt is due to the fact that the tissues of the diaphragm become less elastic, that the fat within the hiatus undergoes atrophy and that thus a locus minoris resistentiae which still must be considered physiologic develops. The Åkerlund Type I and II herniae are encountered only very rarely.—*T. Leucutia.*

BLACKFORD, L. MINOR, and BOOTH, WILLIAM T. Dextrocardia secondary to eventration of the diaphragm. *J. Am. M. Ass.*, March 12, 1932, 98, 883-885.

Dextrocardia as a part of general transposition of the viscera is not uncommon. When dextrocardia occurs alone eventration of the diaphragm should be suspected, this being the most common cause of the condition. A case is reported which was diagnosed as dextrocardia in infancy but the eventration of the left leaf of the diaphragm which displaced the heart was not discovered until the age of sixteen. No symptoms were experienced from the anomaly and the patient lived a very active life, taking part in strenuous athletics. The possibility that subphrenic symptoms may develop or that the weakened diaphragm may be ruptured is considered.—*E. W. Hall.*

SPARKS, J. V. Pulmonary asbestosis. *Radiology*, Dec., 1931, 17, 1249-1257.

Asbestos is a silicate combined with other minerals. During the manufacturing process workers are exposed to its dust. When pulmonary asbestosis once is established stopping exposure to dust will not arrest the progress of the condition. Pneumoconiosis of a characteristic variety is set up and the lungs contain golden yellow bodies which are also found in the sputum. The symptoms and physical signs are described and the clinical data and post-mortem findings in one case are discussed.

The roentgen appearance is usually quite typical in well-advanced cases, but in early cases it is easily overlooked. The movements

of the diaphragm are limited and its outline is indistinct and irregular. There is clouding in the costophrenic angle which may extend along the costal margin to the apices. The heart outline is poorly defined although clinically no displacement of heart or mediastinum is apparent. Occasionally small irregular calcareous deposits about the size of calcified tubercles, but less dense, are scattered throughout lower zones of the chest.—*Ellsworth Johnson.*

LAMARQUE, L., and BERT, J. M. Formes anatomo-cliniques des tumeurs médiastinales et leur sensibilité comparée aux radiations. (Anatomo-clinical forms of mediastinal tumors and comparison of their sensitivity to radiation.) *J. de radiol. et d'électrol.*, Aug., 1931, 15, 416-425.

On the basis of two lymphoid tumors of the mediastinum, which are extensively described in the text some roentgenograms being used for illustration, the authors discuss in general the radiosensitivity of all mediastinal tumors. If the aneurysmal tumors and the simple hypertrophy of the thymus are deducted, they may be divided into two main groups: (I) tumors of lymphoid nature and origin, and (II) non-lymphoid tumors.

I. Lymphoid tumors of the mediastinum. These may be subdivided thus: (a) Lymphoid tumors without modification of the blood picture. These may be again subdivided: (1) typical lymphocytomas of Menétrier, also called lymphomas or lymphadenomas; (2) atypical lymphocytomas, such as lymphosarcoma, lymphadenoma or malignant lymphadenoma. All these tumors are the most radiosensitive of the entire group, they virtually melting away following roentgen exposure so that a diminution in the size within eighteen hours after the first irradiation is not infrequent. (b) Lymphoid tumors with modification of the blood picture. If the leucosarcomatosis of Sternberg, also called sarcoleucemia, which is of a purely theoretic interest and represents a transitory form, is deducted, one may distinguish two main types in this group: (1) The mediastinal form of malignant lymphogranulomatosis, and (2) the mediastinal form of lymphoid leucemia. The response of malignant lymphogranulomatosis to radiation varies according to whether the lesion is in the first or second stage of evolution. In the first stage there is a very favorable rapid and prolonged

response while in the second stage the response is similar to that in generalized carcinomatosis, not infrequently the irradiation remaining inefficacious. The acute and the pleuropulmonary forms likewise are more radioresistant. In the lymphoid leucemia the immediate response is remarkable, large adenopathies disappearing within a short time.

II. The non-lymphoid tumors of the mediastinum. These may be malignant, such as fibrosarcoma, round cell sarcoma, cancer of thymic or thyroid origin, teratoma, etc., or benign, such as lipoma, chondroma, fibroma, adenoma, and dermoid cyst. Whereas in the malignant forms irradiation may bring about a marked reduction in the size of the tumor (within six weeks) without complete disappearance, in the benign forms the response will be nil.

It results from the above that the anatomic structure of the tumors of the mediastinum forms the fundamental element in estimating the radiosensitivity. The administration of the so-called therapeutic "test dose" which is recommended by several authors leads not infrequently to a correct differential diagnosis.

There can be no doubt that radiation therapy, though in the largest number of cases admittedly of only temporary value, represents one of the most powerful curative or palliative agents in the treatment of the principal mediastinal tumors. A bibliography is appended.—*T. Leucutia.*

MOWAT, W. J. The radiographic demonstration of the vena azygos. *Brit. J. Radiol.*, Dec. 1931, 4, 690-692.

During the study of films of the barium-filled esophagus in the routine anterior oblique position, a notching was occasionally detected which could not be explained. After numerous studies it was concluded that the abnormal shadow must represent the end-on view of the horizontal portion of the vena azygos.—*T. Leucutia.*

KAHLSTORF, A. Ueber eine orthodiagraphische Herzvolumenbestimmung. (On an orthodiagraphic determination of the heart volume.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1932, 45, 123-146.

Moritz, Palmieri, Lysholm and Schatzki worked out a method for the determination of the heart volume consisting in a plastic

model of the heart constructed on the basis of the orthodiagraphic findings. This method has the great advantage that it permits the estimation of the form and position of the heart, but it consumes considerable time and therefore is unpractical. Rohrer introduced a new method based on the principle that the volume of any body of a given form is the product of the surface area of its parallel projection multiplied by the middle linear extension in the projected direction. In the heart, the surface area corresponds to the sagittal orthodiagram while the middle linear diameter must be determined indirectly. If the organ is considered as an approximate paraboloid, the middle linear diameter may be obtained by multiplying the constant (0.59 for the paraboloid) with the sagittal diameter of the heart as measured in the lateral projection. By making the necessary corrections for the heart model (constant = 0.63), the following formula is established: heart volume = $0.63 \times \text{surface area} \times \text{maximum sagittal diameter}$.

The author has arrived at the formula of Rohrer in an entirely different way. He considered the heart as a mathematical body occupying a position between an ellipsoid and a paraboloid, and by mathematical calculation he deducted the same formula by likewise taking the constant as 0.63. On the basis of numerous anatomic specimens he found that the volume of the heart is independent of the position of the heart, the source of error in the individual cases amounting to only about 5 per cent. He then determined the normal values for the volume of the heart in adults, arriving at the conclusion that this value is dependent only on the body weight, being its linear function. The heart quotient was determined by dividing the heart volume expressed in cubic centimeters by the weight expressed in kilograms, and it was found that a quotient below 8 in men and 7 in women indicates a small heart, while a quotient over 11 indicates a large heart. The heart volume in women is, on an average, 75 c.c. smaller than in men. This difference is explained on the basis of reduced metabolism and of lessened function of the circulatory apparatus. There is no parallelism between the heart volume and the surface area of the orthodiagram. With like volume a divergence as high as 20 per cent may be encountered in the value of the surface area.

The knowledge of the heart quotient is im-

portant inasmuch as it gives information concerning the size of the heart and in pathological conditions it aids in the differential diagnosis of borderline cases. It is interesting that the normal heart responds to excessive labor with marked decrease in its volume, while the pathological heart shows a tendency towards increase.—*T. Leucutia*.

ZDANSKY, ERICH. Zur Kritik der Kreuzfuchsschen Aortenmessung. (On the critique of the Kreuzfuchs aortic measurement.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1932, 45, 40-45.

In 1920 Kreuzfuchs recommended for the roentgen mensuration of the aorta the contrast filling of the esophagus and the measurement of the distance of the most prominent point of the left aortic knob from the most prominent point of the so-called aortic bed, as evidenced by the pressure of the aorta on the barium filled esophagus. It is admitted that the dimension so obtained is a little too wide due to the fact that the esophageal wall is included in the aortic image. However, since the thickness of the wall of the esophagus is only about 2 mm. the error may be considered negligible.

Several authors have criticized the value of the above method and this no doubt is responsible for its not very widespread practical application. The author analyzes the method from the standpoint of (1) its accuracy; (2) its practical application, and (3) its technical applicability, and arrives at the conclusion that with certain precautions, most of the sources of error can be eliminated. Only in pure mitral vitium and in certain processes with displacement of the mediastinum, esophagus and aorta is the method unreliable.—*T. Leucutia*.

HERSCHER, HARET, and FRAIN. Communication entre l'artère pulmonaire et une ectasie de l'aorte ascendante. (Communication between the pulmonary artery and an ectasia of the ascending aorta.) *Bull. et mém. Soc. de radiol. méd. de France*, Nov., 1931, 19, 445-448.

The authors observed a case of rupture of an aneurysm of the ascending aorta into the pulmonary artery. The roentgenoscopic as well as the roentgenographic examination revealed a butterfly-like shadow of the median portions of the lungs, the heart silhouette in the postero-

anterior view appearing almost completely obscured. In the left anterior oblique position no prominence of the left auricle was noted. As a whole, there was a notable augmentation of the cavities of the heart, especially of the right auricle and right ventricle, and there was a slight prominence of the median arch at the left border. Inasmuch as the clinical diagnosis was that of a pulmonary stenosis, this could not be contradicted on the basis of the roentgen findings. The patient later died with pronounced asphyctic phenomena and at post mortem examination spontaneous rupture of an aneurysm of the ascending aorta into the pulmonary artery was found.

A communication between the aorta and pulmonary artery whether it be congenital or acquired is quite rare. Bonte, in 1929, was able to collect in his thesis 32 cases. According to Sibson aortic pulmonary communication is encountered in 8 per cent of all aneurysms.

It is concluded that the roentgenologic symptomatology varies. There are no characteristic diagnostic signs, whether the aneurysm is actually demonstrated or an enlargement of the right ventricle is the only manifestation.—*T. Leucutia.*

RAVINA, A., SOURICE, A., and BENZAQUEN, L. L'angiographie et l'angiopneumographie. (Angiography and angiopneumography.) *Presse méd.*, Feb. 20, 1932, 40, 287-291.

For the last few weeks the authors have carried out a series of experiments in animals (especially dogs) for the visualization of the arterial system. Sodium iodide, abrodil and tenebril were used as opaque media. The substance was first injected directly into the right ventricle and later, by means of a sound which was introduced from the veins of the neck, either into the right auricle or right ventricle. It is too soon as yet to form definite conclusions but it seems that the method has some value in the study of certain physiologic phenomena of the circulatory system.—*T. Leucutia.*

EDGERLY, E. T., and SPILMAN, H. A. Pneumothorax; a clinical and roentgenologic consideration. *Radiology*, Dec., 1931, 17, 1267-1269.

The object of this paper is to present various findings in the human chest in connection with the presence of air in the pleural cavity, especially as observed in cases of pulmonary

tuberculosis. One is impressed with the necessity for adequate roentgenoscopic and roentgenographic examinations in the selection of cases and the application and control of collapse therapy. For the proper correlation of the roentgen findings, the physical examination, and the clinical course, absolute cooperation between clinician and roentgenologist is essential. Indications for artificial pneumothorax are given.—*Ellsworth Johnson.*

ABDOMEN

REYNOLDS, G. S. The response of the gastrointestinal tract to external electric stimulation. *Radiology*, Dec., 1931, 17, 1276-1280.

In the treatment of chronic constipation it was felt that valuable information could be secured by roentgenoscopic observations of the stomach and colon while they were under electric stimulation. Electric stimulation of the external abdominal muscles over the barium-filled stomach did not produce, during the time of roentgenoscopic observation, any consistent or specific changes in gastric tone or peristalsis. Relatively large amounts of current seemed to decrease peristalsis, while smaller amounts of current seemed occasionally somewhat to increase gastric peristalsis. Electric stimulation over the barium-filled colon produced the following changes: Ascent and descent of colonic flexures and transverse colon; secondary to this ascent and descent of the colon, an alternate lengthening and shortening of the colon occurred; a certain amount of massage effect on the colon was noted. The experiments emphasized the great value of electric stimulation in developing the abdominal muscles. These conclusions are based on the immediate effects of electric stimulation of the gastrointestinal tract and do not necessarily carry any implications as to the results obtainable in a series of treatments.—*Ellsworth Johnson.*

WALZEL, P. Zur röntgenologischen Beurteilung des Situs inversus viscerum totalis. (On the roentgen diagnosis of situs inversus viscerum totalis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1932, 45, 157-159.

The author briefly describes a case which came to operation with symptoms of acute appendicitis. The information gained from the patient that his heart lay on the right side led the author to suspect situs inversus viscerum totalis and therefore he made the incision on

the left side. Following recovery, the patient had several roentgen examinations and the diagnosis of situs inversus viscerum totalis was confirmed. A left-sided appendix is encountered also in mesenterium ileocecale commune, in left-sided position of the colon, etc.—*T. Leucutia*.

PIOT, ÉTIENNE, GOUBERT, JACQUES, and PICARDA. Diagnostic radiologique des pérviscérites. (Roentgen diagnosis of periviscerites.) *J. de radiol. et d'électrol.*, Dec., 1931, 15, 671-679.

Perivisceritis necessitates a careful study on the part of the roentgenologist. Since adhesions can be detected only by indirect signs which vary according to the site of the lesion, a systematic examination of the entire gastrointestinal tract is always indicated. The bulk of information is gained through roentgenoscopic study, roentgenograms being made only for confirmation. It is often advisable to repeat the examination several times.

The author briefly describes the more usual roentgen findings in perigastritis, periduodenitis, perijejunitis, perileitis and pericolitis. If from the beginning an obstruction of the small intestine is suspected, he advises a special technique which is as follows: The patient is placed without preparation on the roentgenoscopic table and examined in dorsal, lateral, semi-inclined, etc., position, for the demonstration of gaseous distention of the loops of the small intestine. Then a tablespoonful of barium (emulsified in paraffin oil) is administered and its passage carefully observed. The patient is left on the roentgenoscopic table during the passage of the barium through the entire small intestine and examination made at repeated intervals. To prevent eventual radiodermatitis more penetrating rays with 2 mm. Al filter and very small diaphragms are used, the position being varied frequently. The procedure may be applied even in case of complete stenosis without too much risk to the patient.—*T. Leucutia*.

DREY. Die Bedeutung des Absaugens des Mageninhalt für die Darstellung des Schleimhautbildes. (The significance of the aspiration of the gastric content for the visualization of the mucosal relief.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1932, 45, 147-156.

The author advises that the contents of an empty stomach be aspirated before proceeding to a roentgen examination for the demonstration of the gastric folds. Such a procedure, especially in the cases with retention, by removing the disturbing secretion and food remnants, permits a better demonstration of the mucosal relief. In cases of suspected ulcer, the examination is repeated after atropine administration for a period of six weeks. By paying attention to these factors, the author was able to increase the correctness of his diagnoses of gastric conditions by about 30 per cent. Nine cases are briefly reported and illustrated with several roentgenograms to prove the value of the method.—*T. Leucutia*.

SANDERA, ROBERT. Kombinierte Kontrastdarstellung des Canalis egestorius. (Combined contrast demonstration of the canalis egestorius.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1932, 45, 57-73.

The canalis egestorius merits greater roentgen attention for several reasons: First, it forms more often the seat of lesions than the rest of the stomach; second, the ulcers occurring in this region are more apt to undergo carcinomatous degeneration; third, the simple ulcers, because of the greater motility of this part of the stomach, are apt to show a more chronic course, and fourth, lesions associated with transmission through the lymphatic system (originating from the pancreas, duodenal bulb, gall-bladder, transverse colon, etc.) are more apt to produce certain deforming changes of the canalis. Several methods have been advocated for the study of this important portion of the stomach, but the author believes that the so-called combined method is the best. This consists in the use of barium sulphate, umbrathor and air. First 350 c.c. of the usual baryt suspension is administered, the water content of the suspension being changed according to indications and a certain amount of sodium bicarbonate being added to neutralize the acidity of the stomach (1 to 2 gm. for anacid or subacid and 2 to 4 gm. for hyperacid or normal stomach). Following completion of the examination with the barium filling, the umbrathor is injected under a very mild pressure. The prior neutralization of the acidity of the stomach allows the better adherence of the umbrathor. If the information gained is still unsatisfactory, air is injected finally under a

pressure not exceeding 50 to 100 mm. on a Recklinghausen manometer. It must be mentioned that both the umbrathor and air are injected by means of a sound, either in the erect or the recumbent (left lateral) position.

The method is of value especially in demonstrating adhesions around the canalis egestorius, which may manifest themselves as transverse folds on the posterior wall of the canalis, or as annular folds, or finally as flattening of the lesser curvature, excentric distentions towards the adherent part, displacement of the pylorus and bulb, etc. Small localized infiltrations of the walls, whether of ulcerous or neoplastic nature, may also be demonstrated. Despite its great value, the procedure is advocated only as auxiliary to the well-known routine methods of examination.—*T. Leucutia.*

O'SULLIVAN, JOHN. Some recent developments in the radiological examination of the gastrointestinal tract. *Brit. J. Radiol.*, Feb., 1932, 5, 97-106.

As the author states, the purpose of this article is to draw attention to refinements that have been evolved in the roentgen study of the gastrointestinal tract within recent years. These developments fall under two heads: (1) a detailed study of the mucous membrane and (2) the employment of snapshot instantaneous photography, this latter being especially applied to the study of the esophagus and the duodenum.

In the following the appearance of the mucosal relief in the normal and in various pathological conditions is discussed. A special chapter is reserved for gastritis with its three types (atrophic, hypertrophic and granular type), for the gastric ulcer and neoplasm, the value of the method in the diagnosis of early malignant changes being especially emphasized, and for the study of the arrangement of the mucosal folds in the duodenum. In the large intestine the relative value of the barium meal, of the suspension enema, combination of air and barium filling and the relief method of examination is considered. The article is well illustrated.—*T. Leucutia.*

KADRINKA, SILVIJE. Étude des muqueuses digestives par des colloïdes opaques. Imprégnation de la muqueuse du gros intestin avec de l'umbrathor. (Study of the digestive mu-

cosa by means of opaque colloids. Impregnation of the mucosa of the large intestine with umbrathor.) *J. de radiol. et d'électrol.*, Nov., 1931, 15, 585-607.

In this article the author deals extensively with the roentgen examination of the colon by means of umbrathor, using numerous very beautiful roentgenograms for illustration.

The method of examination is as follows: The previous evening the patient takes a mild purgative (castor oil) and partakes of a supper consisting only of liquid food with exclusion of fruits and vegetables. The morning of the examination two lukewarm enemas ($1\frac{1}{2}$ liters) are given with one hour interval and the examination is made on an empty stomach, usually 45 to 60 minutes after the last enema. The umbrathor is injected with a 200 c.c. syringe which is attached to an enema tube, the amount varying from 100 c.c. for children to 200 c.c. in adults. To insure a uniform coating of the mucosa of the bowel the patient is laid in various successive positions (left side during passage in the sigmoid and descending colon, knee-chest or Trendelenburg position during passage in the splenic flexure and transverse colon and right lateral position during the passage through the hepatic flexure and ascending colon) and the injection is made very slowly (from 5 to 10 minutes). If a check-up examination reveals that a good coating has not resulted the bowel lumen is distended by additional injection of umbrathor diluted with $\frac{1}{2}$, $\frac{1}{3}$ or $\frac{1}{4}$ amount of distilled water, the total injection never exceeding 350 c.c. umbrathor or 600 c.c. fluid. In some instances it is necessary to apply manipulation to hasten the passage of the umbrathor through certain parts of the bowel. After a uniform distribution of the umbrathor is obtained, roentgenograms are taken and the bowel evacuated. Following this, air is insufflated under roentgenoscopic control, being careful to proceed very gently. Here again the patient is laid in various positions to insure a better passage of the air.

After discussing in detail the normal appearance of the colon, both with the collapsed and distended lumen, the author describes the findings in 13 cases of pathologic colons to prove the value of the method. The opinion is expressed that as a whole the method is superior to that of the barium enema. The opaque layer of umbrathor, because of its chemical adherence, produces a more uniform coating of

the colonic mucosa with increase in the degree of opacity. Moreover the umbrathor, inasmuch as its impregnation depends on the amount of secretion of the bowel mucosa, gives additional information with regard to the function of the bowel. Thus in a subacute hypertrophic colitis, the opaque layer is not only inforced due to enlargement of the mucosal folds but is at the same time thickened due to increased secretion (which leads to increased precipitation of the umbrathor). On the other hand, in atrophic sclerotic colitis impregnation of the mucosa is obtained only with great difficulty or not at all, due to the fact that the secretion of the bowel mucosa is entirely absent or at least qualitatively changed from that of the normal. In deep-seated lesions (stenosis, penetrating ulcers) the after injection of air, leading to distention of the lumen, will aid in estimating the various form changes. Of course numerous errors of interpretation may occur, especially if the technique is not carried out properly. But a repetition of the examination in such instances will as a rule help to arrive at the correct diagnosis. The conclusion is reached that the method is of great practical importance. Its chief advantage is that, as stated above, in addition to the morphologic changes, it gives information concerning the functional disturbances of the colonic mucosa. A bibliography of 22 references is appended.—*T. Leucutia*.

GILBERT, R., and KADRŇKA, S. L'examen de la muqueuse des voies digestives au moyen de l'umbrathor. (Examination of the mucosa of the digestive tract by means of umbrathor.) *Bull. et mém. Soc. de radiol. méd. de France*, March, 1931, 19, 101-104.

In making a comparative study between the effect of barium and umbrathor on the visualization of the mucosal relief, the authors found that the latter is of greater value in all parts of the intestinal tract in which it can be associated with the insufflation of air (pneumogastrography, pneumo-appendicography, etc.).

In the present article the appearance of the mucosal folds in the normal, in chronic hypertrophic colitis, ulcerous colitis, tuberculosis, and tumefactions, is briefly discussed.—*T. Leucutia*.

COTTENOT, CHÉRIGIÉ, LE SAUCE, and MEYER-OULIF. Exploration radiologique du tube

digestif au moyen de sels de thorium. (Roentgen exploration of the digestive tract by means of thorium salts.) *Bull. et mém. Soc. de radiol. méd. de France*, Oct., 1931, 19, 376-380.

Thorium salts form good opaque media because of the very high atomic weight of the thorium (232.15). Kalkbrenner was the first to recommend the use of thorium dioxide (known as umbrathor), which since then has been endorsed by many other investigators. The flocculation of this substance on the surface of the mucosa of the gastrointestinal tract is explained by the fact that the secretion of the bowel neutralizes the electric charge of the colloid, thus leading to precipitation. A more minute study of the problem, however, shows that such a conception may lead to many errors. Thus, the flocculation of a colloid does not always follow the rule of the equimolecular proportions. Umbrathor, for example, is flocculated by small quantities of water of minimum alkalinity. Furthermore, the flocculation comprises three stages: (1) the stage of micellar enlargement which is visible only ultramicroscopically; (2) the stage of micellar agglomeration which is demonstrable nephelometrically, and (3) the stage of total separation of the agglomerated micellae from the intermicellar fluid. This latter is the only one demonstrable roentgenologically and to the unaided eye. Inasmuch as it may assume the most unusual aspects, numerous errors of interpretation may occur. For this reason, the authors recently have completely abandoned the use of the colloidal contrast media and they have prepared some new preparations which are of a crystalloid character. These preparations contain chiefly thorium dioxide, ThO_2 , and the insoluble phosphate salts of thorium $(\text{PO}_4)_4\text{Th}_3$ and $(\text{PO}_4)_3\text{Th H}_2\text{H}_2\text{O}$. They possess increased roentgen opacity, very marked adherence, considerable power of diffusion, perfect stability absolute atoxicity and practically no pharmacodynamic or radioactive effect. Especially three products proved of value: (1) For the examination of the gastric mucosa the so-called mucothor is used, which contains thorium dioxide, 10 gm., mineral excipient, 5 gm. and sodium bicarbonate, 3 gm. The product is a slightly saline white powder. It is intimately mixed with the yolk of an egg and administered in this form to the patient. The sodium bicarbonate is added in order to produce a slight

distention of the stomach by the CO₂ which is liberated by the action of the gastric acid. The patient is placed in various positions until a good impregnation of the mucosal folds is obtained. (2) For the total opacification of the stomach, pulvother is used, which contains thorium phosphate, 90 gm., mineral excipient, 35 gm. and powdered gum, 35 gm. This product is mixed with water and well shaken until a gum-like emulsion is obtained. (3) For the opacification of the intestine a special pulvother is used which contains thorium phosphate, 80 gm., mineral excipient, 70 gm. and sodium sulphate, 5 gm. This product also is supplied in the form of a powder but non-sugared milk instead of water is used for its dilution.

The conclusion is reached that thorium salts are of great value in the roentgen examination of the gastrointestinal tract and that the crystalloid forms give the best results in the visualization of the mucosal relief.—*T. Leucutia*.

DWYER, MAURICE F. Gastric tumors. *Radiology*, Jan., 1932, 18, 80-87.

Approximately 10 per cent of patients consult a physician on account of gastric symptoms and only 15 per cent of these have organic lesions in the stomach or duodenum to account for their symptoms. A gastric tumor occurred in 3.2 per cent of the patients in which 111 gastric cancers, 3 benign tumors, 1 hair-ball and 2 cases of gastric syphilis were found.

The roentgenologist seldom fails to diagnose gastric cancer, yet, the majority of gastric cancers are far advanced at the time of diagnosis. A patient who gives a history of chronic dyspepsia and whose gastric secretions show the presence of free hydrochloric acid may have a cancer of the stomach. In the author's series of patients with gastric carcinoma, 38 per cent gave a history of dyspepsia averaging ten years. Seventy per cent of these had free hydrochloric acid in the gastric contents. A benign tumor of the stomach, although rare, may be the cause of an atypical gastrointestinal complaint, anemia, loss of weight, and weakness. The value of careful palpation of the partially filled stomach during roentgenoscopy cannot be emphasized too strongly. It is inadvisable to diagnose inoperable carcinoma from palpation and the roentgenologic examination alone. The patient should be given the benefit of exploration unless there are skin

metastases or fluid in the peritoneal cavity.—*Ellsworth Johnson*.

BROOKSHER, W. R., Jr. Linitis plastica. *Radiology*, Dec., 1931, 17, 1176-1194.

The literature is reviewed and the pathology described in considerable detail. The term "linitis plastica" is worthy of retention as descriptive of the gross deformity, but, from the pathologic viewpoint, the classification of Dwight as either fibromatosis or carcinoma, diffuse or local in its extent, is considered more suitable. It is evident from the work of Thompson and Graham that fibromatosis, whatever the histological diagnosis, may occur without the presence of cancer.—*E. I. L. Cilley*.

TESCHENDORF, HANS J. Beitrag zur Reliefdiagnostik des Dickdarms. (Contribution to the relief diagnosis of the colon.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1932, 45, 46-56.

The following method is used: After the preparation of the patient, a routine barium enema is applied in supine position. Then the enema is evacuated and roentgenograms of the mucosal relief are made with localization to that particular area. In case of stenosis, or suspicion of stenosis, of the bowel lumen, inflation with air is added. Barium sulphate (350 grams in 1000 c.c. water) is used as the contrast medium. It is concluded that the method is of great practical value. The appearance of the mucosal relief in the normal, in colitis, in carcinomatous changes and especially in intestinal polyps is described in detail and illustrated with numerous roentgenograms. The possible sources of error are also considered.—*T. Leucutia*.

PENDERGRASS, R. C. The roentgen diagnosis of duodenal diverticula. *Radiology*, Dec., 1931, 17, 1216-1229.

An increasing number of cases is being reported, the frequency varying from 0.5 to 5 per cent. Odgers classified duodenal diverticula into (1) primary pouches confined to the duodenum beyond the first portion arising without any coincident pathology; (2) secondary pouches occurring only in the first part and due to chronic duodenal ulcer or traction from adhesive bands, and (3) Vaterine pouches. The roentgenologic diagnosis of duodenal diverticula is discussed with reference to: (a) media

used; (b) roentgenoscopy; (c) roentgenography; (d) suggestive roentgen findings such as a more or less spherical shadow in or near the concavity of the duodenal shadow separate from the duodenum, yet in definite relation to it, persistence of shadow after clearance of stomach, movability of the shadow about a fixed point, usually no tenderness coincident with shadow; (e) types of diverticula with variations in roentgen appearance. The primary type is rounded, ovoid or funnel-shaped, rarely tubular; the secondary type has many variations in shape and is irregular and pointed in outline; (f) differential diagnosis from barium-filled structures such as ulcer craters, redundancies, traction pouches, etc., as well as shadows other than barium such as gallstones, renal calculi, calcified glands, etc.—*Ellsworth Johnson*.

GUTMANN, RENÉ-A. A propos de l'ulcère duodénal de face. (Apropos of duodenal ulcer en face.) *Bull. et mém. Soc. de radiol. méd. de France*, Oct., 1931, 19, 368-371.

The author discusses several diagnostic points of the duodenal ulcer en face. (1) From the topographical point of view; there is marked variation between the operative and roentgen findings, nearly all duodenal ulcers appearing at operation en face, whereas roentgenologically they are situated chiefly on a border. According to the author, this is due to the fact that the niche, which as a rule sits en face, remains unrecognized and that the pseudo-diverticular deformity produced secondarily on the border is diagnosed. Contrary to what was heretofore believed duodenal ulcer en face represents the most frequent and most important type of all ulcers of the bulb. (2) There is also a great difference in the morphological appearance of the ulcer at roentgen examination and on the operative table. Thus the most extraordinary forms (coral, orchid, maltese cross, butterfly, tube-shaped, etc.) may appear on the roentgenograms, whereas at operation the ulcer is nearly always found to be smooth with very little deformity around it. Åkerlund thought that the manifold roentgen appearance was due to edema of the mucosal and submucosal tissues. The author entirely endorses this opinion with the addition that submucous edema is the rule in all duodenal ulcers, spasms appearing quite rarely. If the edema is annular, it may appear in the form of a halo in the

roentgenogram. (3) The acceptance of the notion of intrabulbar edema precludes the use of compression as so often advocated. (4) Inasmuch as most duodenal ulcers do not appear at roentgenoscopic examination, the taking of serial roentgenograms is of prime importance.—*T. Leucutia*.

BARGEN, J. A., and WEBER, H. M. Clinical and roentgenologic aspects of chronic ulcerative colitis. *Radiology*, Dec., 1931, 17, 1153-1157.

The organism of immediate etiologic significance in chronic ulcerative colitis is the streptococcus. The underlying lesions are large shaggy ulcers with intervening strips or islands of mucosa. These islands are granular in appearance, bleed easily, and the diffuse inflammation of the wall results in narrowing of the lumen. The diffuse nature of the disease which involves all coats of the intestinal wall produces a characteristic picture. In about 20 per cent the disease is confined to the rectum and if the disease is of short duration there may be no roentgenologic evidence or the only sign may be that of extreme hyperirritability. Later in the disease the ampulla is markedly narrowed and exhibits a series of coarse linear striations. As the disease progresses, thickening of the wall takes place as do contraction and shortening of the bowel. From a soft pliable, thin-walled, gently winding and twisting tube, the colon becomes a thick-walled, hard, inflexible, stiff straight pipe with a small lumen. Occasionally one or several contracted areas give the bowel the appearance of "a string of sausages." If destruction of the mucous membrane is superficial, the contour of the lumen of bowel may be smooth or feathery and moth-eaten; if the ulcerations are deep the contour is rough and many niche-like projections are seen. Very rarely there are localized areas of chronic ulcerative colitis with involvement of distal segments and rectum.—*Ellsworth Johnson*.

AUBOURG, PAUL. Examen radiologique de 26 caeco-sigmoidostomies. (Roentgen examination of 26 ceco-sigmoidostomies.) *Presse méd.*, Jan. 23, 1932, 40, 125-127.

The author was able to collect a series of 26 cases in which a ceco-sigmoidostomy had been performed for various reasons, the clinical symptomatology always being dominated by a chronic intestinal stasis. A re-examination by

means of opaque meal and opaque enema at different intervals following the operation led to some interesting observations. In 21 of the cases the operative results were excellent and the roentgen examination was made merely as a check-up; in the other 5 the operations led to no result and therefore the purpose of the roentgen examination was to determine the exact nature of the pathologic condition. In injecting the opaque enema it was found that this had entered in all cases both the left colon and the right colon (through the ceco-sigmoidostomy) simultaneously, giving the appearance of a Y. The opaque meal demonstrated, however, that only one-tenth of the substance had passed through the ceco-sigmoidostomy, the remaining nine-tenths having been eliminated through the usual route. It is probable that in the 21 cases in which excellent clinical results were obtained the ceco-sigmoidostomy led to a good drainage of the secretion of the cecal fluid and that this was responsible for the disappearance of the symptoms. In the 5 cases in which no improvement was obtained, the roentgen examination revealed a rather large number of gas pockets in the colon, especially in the hepatic and splenic flexures. It is probable that this accumulation of gas which clinically has produced quite severe spastic crises, is similar to that observed in pneumocoly and aerocoly and therefore the author proposes the name of hyperpneumocoly. A study of the time of evacuation revealed that in the 21 favorable cases the stasis was reduced or entirely disappeared, whereas in the 5 unfavorable cases it continued uninfluenced.—*T. Leucutia.*

AIMÉ, PAUL. L'exploration radiologique des voies biliaires à l'aide du lipiodol, dans le pancréatites. (Roentgen exploration of the biliary paths with the aid of lipiodol in pancreatites.) *J. de radiol. et d'électrol.*, Dec., 1931, 15, 680-684.

The injection of biliary fistulae by means of lipiodol following operation in pancreatitis (cholecystostomy in 2 cases and drainage of the choledochus after cholecystectomy in one case) proved of certain diagnostic value in outlining the biliary passages. It is interesting, however, that the opaque substance, after filling the gall-bladder and the cystic duct, contrary to what one would expect, re-descended into the hepatic duct and its three

branches and only after filling these passed through the ampulla of Vater into the duodenum. The progression of the lipiodol continued even when there was no pressure applied to the syringe. The procedure was found to be entirely painless and without danger. The article includes some very illustrative roentgenograms of the biliary passages.—*T. Leucutia.*

SILVERMAN, DANIEL N. Spontaneous elimination of intestine with temporary recovery: report of a case. *Radiology*, Dec., 1931, 17, 1208-1215.

The author reviews the literature briefly and describes in great detail the case of a woman past middle life in which two separate segments of the intestine were passed by rectum at different times.—*E. I. L. Cilley.*

ELMAN, ROBERT, and GRAHAM, EVARTS A. The pathogenesis of the "strawberry" gallbladder. (Cholesterosis of the gallbladder.) *Arch. Surg.*, Jan., 1932, 24, 14-22.

Moynihan, in 1909, first called attention to small yellowish spots like sand or grit on the mucosa of the gallbladder. MacCarty, because of the appearance of the organ in these cases, used the descriptive term of "strawberry" gallbladder, while Lichtwitz in 1914, was the first to observe that the small yellow deposits were cholesterol. Boyd published the first detailed study of the pathology of this remarkable condition. For a time its existence was generally overlooked, but in recent years it has become more generally known and is now claimed to comprise about one-fifth of all types of diseased gallbladders removed at operation.

Aschoff was apparently the first to maintain that cholesterol is normally taken up by the wall of the gallbladder from the bile. The theory has been generally adopted that the extensive cholesterol deposits found in the "strawberry" gallbladder are the result of a disturbance in the normal absorbing power of the gallbladder for this substance. In contrast to this view, evidence has been obtained in a series of experiments in the laboratory of the authors that seem to show: (1) the gallbladder does not absorb cholesterol; (2) it has the power of excreting cholesterol, and (3) inflammation may accelerate this excretion.

In support of these contentions the following experiments were conducted. 1. When the gallbladder was isolated by ligature of the

cystic duct, the bile therein after a sojourn of from two to sixteen days came to contain a larger amount of cholesterol in all but one of nine experiments. 2. Experiments designed to compare bile subjected to gallbladder influence with that flowing directly from the liver, in the same dog, showed a much greater concentration of cholesterol in the former even when one corrected for the inspissating effect of the gallbladder. 3. Analyses of "white" bile, a product obtained from the isolated bile ducts, showed the presence of cholesterol, which suggests that the entire biliary tract is able to secrete this substance. 4. Comparative analyses of gallbladder and hepatic bile from the same source (human as well as canine) showed that the cholesterol content of the former is much greater than can be accounted for by concentration of the bile.

The authors, in addition, show that infection is the factor of major importance in the pathogenesis of the "strawberry" gallbladder.—*Karl Kornblum*.

GYNECOLOGY AND OBSTETRICS

MACDONALD, COLIN. Some aspects of obstetrical radiography. *M. J. Australia*, March 19, 1932, 1, 398-406.

The author presents a comprehensive exposition of the employment of the roentgen ray in obstetrics. He states: (1) so far there is no evidence to prove that diagnostic roentgenography during pregnancy is harmful; (2) pelvic radiation treatment prior to conception is harmless so far as the health and development of subsequent children are concerned; (3) radiation therapy of a growing embryo in utero, if large intensities of exposure are employed, is likely to result in the birth of a defective child, and (4) irradiation as a means of temporary sterilization or abortion does not appear to be dependable. Five methods of examination are discussed fully. Pneumoperitoneum has fallen out of favor as a roentgenographic procedure due to cardiac and diaphragmatic embarrassments. The lipiodol injection originated by Heuser is stated not to have been attended with the favorable results reported by him in the hands of other workers. The use of gallbladder dye advocated by Albano should be taken "cum grano salis." Unaided roentgenography is the most practical and valuable method at the present time. The general opinion is that fetal structures are visualized

with certainty only after the eighteenth week and a negative finding in the roentgen differential diagnosis of pregnancy prior to mid-term must be given with a reservation that pregnancy is not precluded. The fetal age may be estimated within a month or so and may be dated as having reached the ninth month if a center for ossification for the epiphysis of the lower end of the femur is demonstrated. The upper tibial epiphysis will, in five cases out of six, indicate that the child has passed the ninth fetal month, although this may be absent in 25 per cent of full-term children at birth. Determination of fetal position is especially valuable in breech presentations, and serial films will demonstrate the successful accomplishment of version. Amniography is favorably discussed although the author has had no personal experience with the method. The Spalding sign of intra-uterine death of the fetus has been found correct and of value. The diagnosis of congenital syphilis, monsters and pelvic deformities is detailed. With reference to roentgen-ray pelvimetry, its value is emphasized but the author feels that its ultimate scope of usefulness rests upon the answer to the question, "Are the present clinical methods of estimating disproportion entirely satisfactory?" This question should be answered by the obstetrician.—*W. R. Brooksher, Jr.*

GENITOURINARY SYSTEM

MCCARTHY, JOSEPH F., and RITTER, J. SYDNEY. The seminal vesicles; newer instrumental methods in diagnosis and the therapeutic management. *J. Am. M. Ass.*, Feb. 27, 1932, 98, 687-691.

The precise status of the seminal vesicle as a factor in disease remains to be determined. Catheterization of the ducts is usually possible and should be done in chronic arthritis, vague backache, impotence, and sterility, where other causes have been ruled out and the seminal vesicles are under suspicion. A catheterizing endoscope is described which renders the procedure routinely feasible. With this instrument uncontaminated secretion may be obtained for study, diagnostic vesiculography may be done, and therapeutic lavage be carried out.

The author uses 30 per cent sodium iodide colored with methylene blue, outlining individual sacculi and showing dilatation or constrictions of these structures. One case of acute urinary retention had for its cause enormously

dilated seminal vesicles. Congenitally large sacculi, congenital defects or arrests, large hypotonic vesicles and chronic inflammations are among the conditions demonstrated in the series of 50 cases.—*E. W. Hall.*

JECK, HOWARD S. Horseshoe kidney with especial reference to surgical technic. *J. Am. M. Ass.*, Feb. 20, 1932, 98, 603-609.

The author studied 26 horseshoe kidneys occurring in 16,735 autopsies at Bellevue Hospital, an incidence of 1 in 643. The average age at death of persons with horseshoe kidney is slightly lower than of normal individuals and these kidneys are more prone to disease than kidneys normally developed.

Preoperative diagnosis is now almost the rule, although before the days of urography it was the exception. Operative procedure is more difficult with horseshoe kidneys and greater precautions are necessary due to the extensive and anomalous blood supply, the possible presence of two ureters on the same side, the size and character of the isthmus, the relative immobility of the kidney and the possibility of rarer anomalies such as fusion of the suprarenals. Care must be taken in case of heminephrectomy that the other half of the kidney has a normally functioning ureter. A large extra-peritoneal incision is advisable.—*E. W. Hall.*

JOELSON, JAMES J., and ZOLLINGER, ROBERT.

Iopax; an analysis of the results obtained in forty-five cases, with report of a case showing a severe reaction following injection of iopax. *J. Am. M. Ass.*, March 5, 1932, 98, 799-803.

Completely satisfactory pyelograms were obtained in only 40 per cent of the cases and diagnostic pyelograms in only 51 per cent. The dose used was about 25 grams for children and 40 grams for adults. Higher dosage was not employed because of the mild reactions occurring even with this amount and in the series of 45 cases one patient had a very severe reaction lasting sixty hours.

One of the chief deficiencies of the method is the incomplete visualization of the minor calyces, and this renders it rather unsatisfactory for diagnosis of tuberculosis. In pyelitis of childhood, urinary lithiasis, congenital anomalies and nephroptosis it gave best results.

The author feels that while the method of urography by iopax is a valuable addition to our methods of diagnosis in certain cases it will

never replace cystography and retrograde pyelography.—*E. W. Hall.*

MORRIS, HAROLD L. The demonstration and significance of nephroptosis and urinary stasis. *Radiology*, Jan., 1932, 18, 56-73.

Each kidney occupies the upper third of the lumbar fossa extending from the upper margin of the twelfth rib to the lower margin of the second lumbar vertebra. The right kidney lies about a finger's breadth lower than the left.

The fixation of the kidney depends on several factors: the fatty capsule through which connective tissue fibers run from the fibrous capsule to Gerota's capsule; Gerota's capsule; pressure exerted by the abdominal viscera; the muscular tone and development of the abdominal viscera; the muscular tone and development of the abdominal walls; the nephrocolic ligament, and the kidney pedicle.

The movable kidney may be described as one which moves with abnormal freedom behind the peritoneum. A long list of symptoms as well as diseases has been attributed to ptosed kidneys, with resultant urinary stasis. By pyeloscopy it can be shown that the normal renal pelvis and ureter undergo very definite rhythmic contractions and dilatations. Many variations of these are observed in the abnormal. Pyeloscopy is but a preliminary procedure to pyelography and is indicated in every case.

Five-tenths cubic centimeter of skioldan is injected through the catheter to locate the tip and its relation to the renal pelvis. After the initial injection 1 c.c. at a time is added until the entire pelvis is clearly outlined; roentgenograms are made, the degree of respiratory excursion of the kidney is noted, and the actual amount of excursion from the prone to the vertical position is observed. Having noted the renal motility in the erect posture, the next problems to decide are: (a) Is there any retention or interference with the normal emptying of the renal pelvis while in the erect posture? (b) Does the renal pelvis normally contract and relax? (c) Is the kidney fixed or rotated so that stasis results? These questions can most satisfactorily be settled only with a table that places the patient in the standing position.—*Ellsworth Johnson.*

SKELETAL SYSTEM

CARP, LOUIS. The roentgenologic displacements in Colles' fracture, with special refer-

ence to the mechanism of the accompanying fracture of the ulnar styloid: a report of one hundred consecutive cases. *Arch. Surg.*, Jan., 1932, 24, 1-13.

This study was undertaken to show: (1) the usual roentgenologic displacements in Colles' fracture with an accompanying fracture of the styloid process of the ulna and the practical therapeutic value of such information, and (2) the probable mechanism of fracture of the ulnar styloid.

The frequency of the various types of displacements encountered in 100 consecutive cases is tabulated, with accompanying roentgenograms of representative types. From this part of the study it was concluded that most Colles' fractures accompanied by fractures of the ulnar styloid have sufficient (96 per cent) displacements of the lower radial fragment to warrant reduction in order to obtain the best possible anatomic realinement which is usually essential for the best end-results.

To determine the mechanism of fracture of the ulnar styloid an anatomic study was made of the ligamentous attachments to the ulnar styloid to determine lines of stress and strain with respect to the accompanying fracture of the radius and the other bony structures, a notation was made of the sites of fracture of the styloid process, with their various displacements as shown by the roentgenograms, and the positions and displacements of the lower radial fragment, as shown anatomically and roentgenologically, were correlated. For this purpose the wrist joints of 22 cadavers were dissected to note the ligamentous attachments to the ulnar styloid. The anatomy of the wrist joint with special reference to the ligaments is described and shown in drawings.

From this study it is concluded that the ulnar styloid in Colles' fracture, in the great majority of cases, is fractured at the base by the pull of the intra-articular fibrocartilage of the wrist joint and at the middle and tip by the pull of the ulnar collateral ligament. It is logical to assume that both ligamentous structures may act together to produce fracture of the ulnar styloid, especially when the fracture occurs in two or three places simultaneously. Direct violence probably plays a negligible rôle in any of the fractures of the ulnar styloid, although forceful sudden impact of the carpus against the styloid may be the cause in a very small percentage of the cases.

The article is concluded by quotations from the literature on the mechanism of fracture of the ulnar styloid in Colles' fracture. Most of these were in accord with the conclusions arrived at by the author.—*Karl Kornblum.*

KRAFT, ERNEST. Melorheostosis Léri: A flowing hyperostosis of a single extremity. *J. Am. M. Ass.*, Feb. 27, 1932, 98, 705-709.

The disease as described by Léri and Joanny in 1922 is characterized by a hyperplastic bone lesion which involves a single extremity extending from one end to the other in a single track but leaving a few areas normal. Other writers have called the disease "osteosclerosis," "osteosis eburnisans monomelica" and "osteopathia hyperostotica congenita (unius membri)." The pathological change is essentially a proliferation of ivory-like new bone in cortical areas. The morphology of the lesions varies greatly but it confines itself to one side of the bone, and forms a linear track parallel to the long axis. Bony masses form in the soft tissues about the shoulder or hip, and ankylosis may occur.

The first signs of disease appear usually in childhood or adolescence. Pain is present at some stage to a slight degree, though limitation of motion and transient stiffness are chief complaints. The disease is progressive, though never fatal, and has never given evidence of malignant character. The etiologic factor is unknown, various authors ascribing it to vasomotor neurosis, infection, endocrine disturbance, and embryonic defects. A tabular description of 16 cases is given including 2 from the author's practice.—*E. W. Hall.*

WYATT, TYREE C., and McEACHERN, THOMAS H. Congenital bone dysplasia (osteogenesis imperfecta) associated with lesions of the parathyroid glands. *Am. J. Dis. Child.*, Feb., 1932, 43, 403-415.

The authors report a case in which there was marked congenital bone dysplasia and unusual vascularity of the parathyroid glands with a relatively small amount of parenchymal tissue. The possibility is suggested that so-called "osteogenesis imperfecta" may sometimes be based in part on a congenital parathyroid disturbance rather than be purely the result of faulty mesoblastic differentiation.

The case reported showed the typical roentgen picture of osteogenesis imperfecta of con-

genital origin. The patient died soon after admission and no complete study of the calcium balance could be made. The normal calcium and phosphorus values in the blood were in accord with those reported in osteogenesis imperfecta. They do not suggest a parathyroid disturbance. However, these bones, Wyatt and McEachern suggest, presumably never had their normal content of calcium salts and this could possibly explain calcium and phosphorus levels in the blood which differ from those of the characteristic parathyroid disturbance of later life.

They had the impression that there was a smaller amount of gland parenchyma in this patient than is usually seen. However, the question can be raised as to the possible influence of such great vascularity on the amount of secretion absorbed into the blood. In view of the conflicting experimental evidence, it would seem that the changes in the bones in this case could have resulted from either decreased or increased parathyroid function during the period of growth. On the other hand, the bone dysplasia and the changes in the parathyroid glands may be purely coincidental. In the case reported by Weber, who suggested a primary lack of mesoblastic development, the osteoid tissue tended to be more abundant and showed less evidence of calcification and thus differed from the case reported by Wyatt and McEachern.—*R. S. Bromer.*

HUNTER, DONALD, and TURNBULL, HUBERT M. Hyperparathyroidism: generalized osteitis fibrosa, with observations upon the bones, the parathyroid tumours, and normal parathyroid glands. *Brit. J. Surg.*, Oct., 1931, 19, 203-284.

MacCallum, Voegtlin, Hanson, Collip, Brehme, György, Reiss, Aub, Hunter et al, have done experimental work showing the effects of parathyroidectomy and administration of parathormone on blood and urinary calcium and phosphorus as well as on blood viscosity. Overdosage with parathyroid extract produces hypercalcemia as shown by experiments with dogs, this hypercalcemia being manifested by loss of appetite, dullness, drowsiness, atonia and failing circulation. Overdosage in men produces hypercalcemia without such marked clinical symptoms.

Von Recklinghausen described generalized osteitis fibrosa in 1891 without apparent

knowledge of its etiology. Askanazy described a case in 1904 with parathyroid tumor, the significance of which was unsuspected. Erdheim in 1907 first called attention to the relationship of bone pathology to parathyroid enlargement. Mandl in 1926 first removed a parathyroid tumor for osteitis fibrosa and greatly benefited the patient.

Abstracts of 29 published cases of generalized osteitis fibrosa are presented.

The author presents 4 cases of generalized osteitis fibrosa and hyperparathyroidism, with excellent detailed clinical and pathological reports, which demonstrate the etiologic relationship of the parathyroid to this disease. He also presents 4 cases of focal osteitis fibrosa and one of osteomalacia with blood chemistry, histology and metabolism which seem to prove the absence of hyperparathyroidism in these diseases. Osteomalacia is associated with deficiency in sunlight and vitamins and improves with treatment as a deficiency disease.—*E. W. Hall.*

BRADFIELD, E. W. C. A case of generalized fibrocystic disease of the bones. *Brit. J. Surg.*, October, 1931, 19, 192-202.

The case is unusual in regard to the long period of observation, which extended over twenty-three years. At the age of six, cystic areas were shown in both femora, both humeri and the left tibia. No cysts were demonstrated in the skull at that time though it was asymmetrical. The usual repeated fractures brought the patient several times under observation. As an adult he shows marked deformities, markedly cystic bones in which practically all normal structure is blotted out. Microscopic examination of removed tissue showed osteoid tissue imbedded in vascular marrow in varying stages of fibrosis and numerous cartilaginous areas. Interesting roentgenograms and photomicrographs illustrate the report. Laboratory findings throw no definite light on the etiology of the disease. It does not seem to fit into the usual parathyroid syndrome though the possibility of its being a quiescent stage of this condition should be borne in mind.—*E. W. Hall.*

GILES, ROY G. Vertebral anomalies. *Radiology*, Dec., 1931, 17, 1262-1266.

The importance of these anomalies in relation to actual or alleged injuries is of great in-

terest to all medical men. The name normal variations is suggested in place of congenital anomalies, since these individuals are in a way as normal as those having the standard pattern. In the author's series of 8,000 cases of genito-urinary examinations showing the lumbar spine and pelvis, vertebral anomalies were noted in 1,122 roentgenograms. His findings as to spina bifida, sacralization of the fifth lumbar, hemivertebrae, and anomalies of number and rib attachments are somewhat higher than, but agree well on the whole with, the findings of other workers who are quoted clearly and concisely. The author concludes that employees in hazardous occupations should have the spine roentgenographed routinely when hired and that the determination of direction and amount of force causing an injury is of great help in interpreting confusing roentgenograms.—*E. I. L. Cilley.*

CAPENER, NORMAN. Spondylolisthesis. *Brit. J. Surg.*, Jan., 1932, 19, 374-386.

The author states that slipping of an intact fifth lumbar vertebra is a very rare condition and he devotes the entire article to spondylolisthesis occurring following spondylolysis, meaning the separation of the laminae from the body. Thirty-four cases from the material at the University of Michigan are studied. In many patients, though not all, trauma was the causative factor. The types of injury that produce fracture of the spine may also produce spondylolisthesis. Slipping on only one side produces rotation and scoliosis.

Diagnostic points to observe in the roentgen examination, which includes a good lateral view, are: (1) alinement of the anterior and posterior borders of the vertebral bodies; (2) normal width of the intervertebral disc; (3) shape of intervertebral foramina; (4) continuity of the neural arches; (5) length and relation of spinous arches; (6) evidence of structural bone changes; (7) degree of lumbar curve and angle of the sacrum, and (8) evidences of spontaneous arrest.—*C. L. Martin.*

REISS, OSCAR, and KATO, KATSUJI. Gaucher's disease; a clinical study, with special reference to the roentgenography of bones. *Am. J. Dis. Child.*, Feb., 1932, 43, 365-386.

Gaucher's disease has of late aroused a considerable amount of interest in spite of the comparative rarity of the condition. The authors

define it as a familial, chronic, constitutional, non-hereditary disease of metabolism, which is characterized by the deposition of cerebroside kersin in certain cells of the reticulo-endothelial system. Clinically, it shows splenohepatomegaly, without ascites, occasional lymphadenopathy, subicteric pigmentation of the exposed parts of the skin, pinguecula-like thickening of the ocular conjunctiva, hemorrhagic diathesis, unique changes in the bones, a hypochromic type of anemia, slight but early leucopenia, frequent thrombocytopenia and spastic irritative contractions and tremors of a central type. The literature is reviewed by the authors in detail. The morphological characteristics, the chemical contents and the origin of the distinctive cell are described. The so-called large Gaucher cells are peculiar to the disease, contain complex substance in their cytoplasm with eccentrically placed nuclei, and are found in all the organs of the body where the elements of the reticulo-endothelial system are found.

The roentgenologic examination of the bones in Gaucher's disease has furnished a large amount of information as to the nature of the changes in the skeletal system. By this method, one is able in many instances to offer positive data which aid in the ante-mortem diagnosis of the disease. Of all the bones in the body, the femur shows the most typical changes. In the early cases it may be the only bone affected. The change in the lower end, most frequently seen, consists of the presence of areas of rarefaction of varying sizes, which in some cases are intermingled with areas of sclerosis, the so-called "worm-eaten" or "punched-out" picture. The cortex is thin and extremely irregular, especially toward the middle portions of the diaphysis. One or more growth arrest lines may be visible just shaftward to the epiphyseal edge. There is often a very interesting finding of swelling or fullness on each side of the shaft just above the condyles. The swelling may become so marked that the normal contour of the femur at its distal end, with a concave flaring of the condyles, may be transformed into the shape of an Erlenmeyer flask or may resemble a club shape. When correlated with other findings this may be regarded as a diagnostic sign of the disease.

In the authors' cases the hip joint signs were outstanding items in the history. Roentgenologic examinations revealed osteoporosis with

extensive areas of rarefaction, mingled with those of condensation. Pathologic fractures through the neck of the femur were also found, with angulation of the fragments, causing a coxa vara appearance. This latter change may even appear in the absence of fracture. The head of the femur sometimes is flattened, resembling the deformity of Perthes' disease, chronic osteomyelitis or tuberculous coxitis. The portion just below the neck often showed a mottled appearance, owing to juxtaposed areas of rarefaction and condensation, with irregularities in the thickness of the cortex.

The same changes are seen in all the other long bones, especially the humerus, tibia, radius, ulna, and ribs. The pelvis is also frequently involved.

Reiss and Katsuji had no cases in which the vertebrae were involved. When any portion of the spinal column is affected, there is usually produced a compression fracture of the spine due to gibbus formation. The Gaucher cells are present in nearly all of the bones of the column, but the actual deformity and compression fracture may be limited in number. Pick has emphasized the fact that the intervertebral discs are usually intact, in spite of the extreme degree of bone destruction, a point that differentiates the condition from tuberculous spondylitis.

One case of involvement of the skull bones has been reported, that of Pick. Here the calvarium was affected, the diploë being filled with a Gaucher cell mass, and the inner surfaces of the parietal bones contained symmetrically placed yellowish spots of these cell nests.

On section of the affected bones, numerous small, thick, whitish areas, arranged in a sclerate form, either in nodes or in streaks, or sometimes in a net-like manner, are found. These areas contain the large typical cells, which for the most part retain the same shape found in other organs of the lymphatic-hematopoietic system, but where they are compressed between unyielding walls, as between the trabeculae of spongiosa, they may assume an elongated and spindle form, often resembling the fibers of smooth muscle. These masses of Gaucher cells may be intermingled with lymphoid cells, and in hematopoietic tissues of the myeloid areas they are intimately mixed with red blood cells. When the disease is long continued, the accumulation of Gaucher cells and

the consequent pressure on the surrounding tissues may cause necrosis of the spongiosa, leading to rarefaction and irregular lining of the cortex. When such necrosis occurs near the epiphysis, pathological fractures may occur. The intervertebral discs never become deformed, although they may be filled with Gaucher cells and hold the deformed vertebrae in their substance.

Splenectomy is the only method of treatment. Surgical intervention, however, gives only temporary relief and has no value as a cure for the disease.—*R. S. Bromer.*

GIRDLESTONE, G. R. The pathology and treatment of tuberculosis of the knee-joint. *Brit. J. Surg.*, Jan., 1932, 19, 488-507.

Tuberculosis of the knee may be divided into three groups on points elicited from stereoscopic roentgenograms. They are: (1) the extra-articular type having purely extra-articular foci; (2) the focal-articular type with bone foci communicating with the joint, and (3) the non-focal type in which no foci can be seen in the roentgenograms. Treatment can be administered on the basis of three age groups divided as follows: (1) young children from 0-10 years for whom prolonged immobilization is indicated, but neither diagnostic arthrotomy nor fusion; (2) adolescents and adults, 15-50 years, for whom immobilization is preparatory to confirmation of diagnosis by arthrotomy, followed by fusion, and (3) the elderly from 50 years onwards for many of whom amputation is wiser than fusion.

Emphasis is laid on the fact that treatment should be started in children as soon as the clinical signs appear, and not after roentgenographic evidence of bone and cartilage is obtained if functioning joints are to result. Diagnostic arthrotomy is condemned except in older patients where fusion is to follow. A large portion of the article deals with treatment, and operative procedures are discussed in detail.—*C. L. Martin.*

LERICHE, RENÉ, and FONTAINE, RENÉ. De la valeur thérapeutique des infiltrations péri-articulaire à la novocaïne dans les entorses et les arthrites traumatiques. (The therapeutic value of periarticular injections of novocaine in sprains and traumatic arthritis.) *Presse méd.*, Feb. 20, 1932, 40, 280-282. The authors recommend the periarticular in-

jection of novocaine for the treatment of sprains and traumatic arthritis. The term "traumatic arthritis" is reserved for the designation of prolonged functional disturbances which are always associated with pain and occur after articular traumatism without fracture and in which, even in the advanced stages, no other anatomic findings can be demonstrated than a slight osteoporosis of the articulations involved. If left alone some of the patients afflicted with this condition may recover spontaneously, but the majority will develop a more or less permanent functional disability. The novocaine is injected periarticularly in the amount of 10 to 25 c.c. of a 1 per cent solution (without adrenalin), the injections being made every day or every other day until healing is obtained. Three cases representing typical examples are described in detail and illustrated with photographs and roentgenograms. The method is entirely harmless. It must be mentioned, however, that only the acute cases are amenable to permanent healing, whereas in the chronic cases an improvement is all that can be expected.—*T. Leucutia*.

BLOOD AND LYMPH SYSTEM

EMPEY, LUCAS W., and PROESCHER, FREDERICK. Agranulocytosis; report of a case, with autopsy observations. *Am. J. Dis. Child.*, April, 1932, 43, 947-972.

The authors report a case of primary, idiopathic agranulocytosis in a child, aged three and one-half years. The case history is given with attention to detail. Their study of the case supports the view that the disease is caused by an unorganized noxious agent that acts on the bone marrow. They support this theory by the fact that no evidence of a focal infection could be demonstrated clinically, previous to the time the granulocyte count fell so low as seriously to impair the body's defense against saprophytic organisms; by the type of necrosis that was found pathologically; by the fact that a blood culture was negative during an afebrile remission of the disease, even though the granulocyte count was gradually falling.

The only noxious agent that they could find in this case was exposure to the fumes given off by the flue of a gas-burning furnace in the home for a period of three weeks at least. This exposure occurred more than twelve months prior to the appearance of the first symptoms attributable to the disease. They suggest more

careful inquiry in cases in the future into possible exposure to such gases.

The treatment of their case consisted in leucocytic extract in large doses, a daily injection of 5 per cent nucleic acid, stimulation of the long bones with small doses of roentgen rays, injections of whole pituitary solution (Armour), autogenous vaccine, blood transfusions and oral hygiene with perborate mouth washes. In addition the patient was given one vial of liver extract and two dessert spoonfuls of codliver oil daily. The diet was purposely low in fat. Blood transfusion and oral hygiene were the only therapeutic measures that seemed to be of value.—*J. C. Rosen*.

BATY, JAMES M., BLACKFAN, KENNETH D., and DIAMOND, LOUIS K. Blood studies in infants and children. I. Erythroblastic anemia; a clinical and pathologic study. *Am. J. Dis. Child.*, March, 1932, 43, 667-704.

This is a very complete study of erythroblastic anemia. The article consists of an introduction; a review of the literature; clinical and pathologic aspects, including age, incidence, symptoms, physical findings, roentgen findings, hematological data, hematological data following splenectomy, other laboratory data; pathology including the bone marrow and bone, spleen, liver and lymph glands; the course and prognosis, differential diagnosis, and treatment. These sections are followed by comment on the cases reported, a summary and a complete report of 20 cases.

To cover all of these sections in an abstract is impossible because of lack of space. The article should be read in order to grasp its complete description and discussion of the disease. The authors state that the roentgen findings are constant and characteristic. They vary in degree in different patients and in different bones of the same patient, with a tendency to become more marked as the disease progresses.

The long bones show unusually prominent medullary trabeculations, especially at the metaphyseal ends of the diaphyses. This is most marked in the small bones, the metacarpals and metatarsals, because of the better detail obtained in the roentgen films. The changes can be recognized here most easily and in the earliest stages. The total width of the bone is definitely increased, owing to the widening of the medullary portion, which shows rarefaction and increased trabeculation. The corti-

cal portion, however, is markedly thinned and occasionally presents punched out areas. When the process is more advanced and the cortex is exceedingly thin, pathologic fractures may occur.

The cranial vault, in the early stages of the disease or in milder cases, shows only a slight thickening and an increased porosity of all bones with thinning of the tables. In the advanced stages, the depth of the bony structure becomes so thin and porous that it cannot be detected as a distinct plane. The diploë is very prominent and seems to extend beyond the outer table. The profile view of the skull then gives the appearance of a surface studded with small radiating spicules perpendicular to the tables of the skull. The fuzzy outline is described best by the phrase "hair standing on end." The rest of the skull plate has fine spongy appearance.

There are irregular trabeculations, increased porosity and radiability in the bones of the pelvis, the vertebrae, the ribs, the clavicles and the scapulae.

In the authors' summary the disease is defined as a disease entity of unknown etiology characterized by a racial, congenital and often a familial incidence, enlargement of the spleen and to a lesser degree of the liver and peripheral lymph nodes, a slowly progressing anemia accompanied by large numbers of nucleated erythrocytes in the peripheral blood, peculiar changes in the bones, a characteristic facial appearance and, histologically, erythropoietic hyperplasia of the bone marrow and extensive erythropoiesis in the spleen.—*R. S. Bromer.*

VASILIU, TITU. Conceptions étiologiques et pathogéniques, de la lymphogranulomatose, tirées de son étude expérimentale. (Etiologic and pathogenic conceptions of lymphogranulomatosis as drawn from its experimental study.)

FAVRE, and CROIZAT, P. Caractéristiques générales du granulome malin tirées de son étude anatomo-clinique. (General characteristics of malignant granuloma as drawn from its anatomo-clinical study.) *Presse méd.*, Jan. 6, 1932, 40, 25-27.

These two articles represent reports which are part of a symposium on lymphogranulomatosis as presented before the third full session of the Anatomic Society of France. The

first concludes with the assertion that the tuberculous nature of lymphogranulomatosis cannot be completely rejected but that, on the other hand, bacteriologic and experimental investigations have not brought sufficient proof as yet of the existence of another type of pathologic germ. The second states that lymphogranuloma, despite its many variations, represents a definite entity both from the histologic and clinical standpoint which must not be, because of the many atypical forms, confused with the diffuse group of reticulo-endothelioses of various origins.

Sluys in discussing the value of roentgen therapy expresses the opinion that the fractionated roentgen therapy applied only for the manifest lesions should be replaced by total irradiation over large fields with small frequently repeated doses, or, still better, by a general irradiation of the entire body at great distance (teleroentgen therapy).—*T. Leucutia.*

COOLEY, THOMAS B., and LEE, PEARL. Erythroblastic anemia. *Am. J. Dis. Child.*, March, 1932, 43, 705-708.

The authors state that further experience with erythroblastic anemia has strengthened their conviction that it is a clinical entity. In reviewing the series of cases originally reported by Cooley, they have now determined that all of the proved cases occurred in Greeks or Italians, and Sicilians. They are not inclined to lay great stress on the limitation of this or any other similar disease to a particular race, as it seems likely that any disease in which there is a hereditary element is limited more by locality and association than by race. The first case is probably a "sport" and the spread from it naturally occurs first in the same locality and among people of the same race. If a similar "sport" occurs in another locality and in another race, a second focus may arise.

The red cell in this anemia is a very large cell with a markedly uneven distribution of hemoglobin. It is a morphologic giant which is not functional because of a defective supply of hemoglobin. It has also an abnormal stroma. Some microcytes in contradistinction to this macrocyte are found also. The only anemia of childhood presenting a similar picture is sickle cell anemia. In this disease the cell is not usually so large, but it shows the same uneven distribution of hemoglobin. It also gives the same results with the stroma stain.

Normoblasts in large numbers and a moderate number of megaloblasts are observed almost invariably. Reticulocytes are usually present in a considerable proportion, from 10 to as high as 30 per cent. Leucocytosis is almost constant and at times of high degree. The type of cell varies and is not characteristic. At times two of the patients of the authors' series have had an aplastic picture with leucopenia and scarcity of polymorphonuclears and platelets.

Their patients showed, on the whole, a higher degree of serum pigmentation than those of the series reported previously from Boston, the index being from 8 to 30 or even higher, though periods occurred when it fell to normal. With one exception, in which the findings were normal, all their patients have shown an increased resistance in tests for fragility. In regard to pathologic findings they have nothing new to report since their earlier case reports and those reported by the Boston group. They have come to believe that splenectomy, in addition to relieving the child of the burden of the enormous spleen, may retard the progress of the disease. While hemolysis is a constant and important feature, they are no longer inclined to believe that the disease is primarily a hemolytic disorder in the sense that hemolytic icterus is. The apparent relationship is greater to pernicious anemia and sickle cell anemia, and it seems to them probable that the urge to put forth

quantities of immature cells and the resultant hyperplasia of erythropoietic tissue may be the result of some metabolic disturbance which compels these tissues to make "bricks without straw."—*R. S. Bromer.*

GENERAL

RHINEHART, D. A. Air and gas in the soft tissues: A radiologic study. *Radiology*, Dec., 1931, 17, 1158-1169.

The shadows of gas in the soft tissues is of great importance in many types of injuries. It may be carried in by the traumatizing agent or introduced with irrigating agents such as peroxide of hydrogen. Introduced air is of little importance clinically and will usually be absorbed in from ten to twelve hours. Gas in the roentgenogram is the first positive sign of gas infection. In a series of cases at the Little Rock Hospital the diagnosis of gas infection was made clinically an average of fifty hours, and by roentgen ray an average of nineteen hours after injury. If the gas is of infectious origin it will show definite increase in amount after six hours. Introduced air will show no advance. The type of gas infection cannot be determined by the roentgen ray alone; however it is of great importance in determining the extent of the infection as well as in directing operative procedures.—*E. I. L. Cilley.*



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THE PINEAL BODY ROENTGENOLOGICAL CONSIDERATIONS

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THE pineal body (corpus pineale), or epiphysis cerebri, is a cone-shaped body which is about 8 to 10 millimeters in length (Piersol) and rests on the dorsal aspect of the brain in the triangular pineal depression between the superior corpora quadrigemina and between the posterior ends of the two thalami. It is attached by a hollow peduncle to the roof of the third ventricle near its junction with the mid-brain and thus lies near the aqueduct of Sylvius. It is important that the roentgenologist remember its normal position that he may be better able to understand and correlate the clinical with the roentgenological findings in the diagnosis of tumors arising from this region. Examination of the brain shows that the pineal body occupies almost a central position in the skull being normally in the midline slightly posterior to the center of the anteroposterior diameter and slightly below the center of the vertical diameter. It is important to remember this rather central position that the readiness with which it is displaced by intracranial lesions may be better understood.

HISTOGENESIS

A knowledge of the embryogenesis is necessary for any serious attempt to interpret the clinical pictures presented by tu-

mors arising from the pineal body and to correlate them with the roentgenological findings in arriving at a correct diagnosis. Globus and Silbert examined microscopically the pineal body from 9 fetuses, 18 infants, 25 children and 22 adults. At the second month of fetal life they found the pineal to consist of a dense mass of cells. This, as Bailey and Cushing state in their recent book, consists of proliferation of the medullary epithelium in one area of the roof plate to form the anlage of the pineal body. The structure of tumors arising from the pineal body frequently resembles the large undifferentiated cells described by del Rio Hortega, Krabbe, Globus and Silbert, and Bailey and Cushing. The latter authors believe that the embryonic pineal body contains neuroglial cells. This opinion is not universally accepted. Globus and Silbert found the pineal at five months to contain evidence of a primitive glandular arrangement. At birth may be seen the characteristic mosaic structure formed by groups of the small dark cells lying between masses of the larger, lighter parenchymal cells. Very large vascular channels are found at the periphery of the gland. At nine weeks after birth the mosaic nature of the structure begins to lose its definite character. At five months, there remain of the small dark

cells only a few islands, as these elements are rapidly changing into fibroblasts to form the supporting structure. At eighteen months, the parenchymal cells are grouped into alveolar arrangements by definite connective tissue trabeculae. At five and one-half years, the gland is much like the adult structure, consisting of alveoli separated by a connective tissue framework. *The only further changes are degenerative, consisting chiefly of fibrosis, hyalinization, cyst formation, and calcification.*

FUNCTION

The function of the pineal body in the human organism is still a subject of controversy. Some consider it to be a gland of internal secretion; others, a vestige of the median eye of certain reptilian forms. Descartes even suggested that it might be the seat of the soul. This, of course, is not seriously considered at the present time. Berblinger states that, in regard to the function of the pineal body, physicians are still in the stage of collecting evidence. Globus and Silbert believe that the glandular character of the pineal body cannot be disputed, at least at some stage of its development. This is particularly striking at about the sixth month of uterine life. During the early months of post-natal life, it loses this structural character and assumes a new architecture, which does not permit of functional interpretation. Thus, it would appear that the glandular function is short lived. Extensive studies by Krabbe led to similar conclusions. Tilney and Warren believe that the pineal body of the embryo contains glandular elements. Von Volkmann is of a similar opinion. Dana and Berkeley believe that the pineal body has secretory function, having to do with the processes of nutrition and growth, and that its overactivity apparently produces sexual and mental precocity. Horrax and Bailey, on the other hand, are rather skeptical with regard to the secretory structure of the pineal body; del Rio Hortega has been unable to find evidence of secretory activity of this structure.

Nomenclature. I prefer the term "pineal body" to "pineal gland" since the latter term implies glandular potentialities. Since this point is controversial it is better for the roentgenologist to employ the indifferent, non-partisan term—"pineal body."

VISUALIZATION

It has long been known by the histologist that the pineal body frequently contains calcareous deposits. This calcification, as Globus and Silbert have pointed out, is probably merely a degenerative change in the pineal body associated with fibrosis, hyalinization and cyst formation. Del Rio Hortega in a recent study of calcareous concretions in meningiomas and gliomas also rather fully discusses the calcareous changes occurring in the choroid plexus and the pineal body. The chief concern to the roentgenologist is the fact that in a majority of adults the calcareous deposits render the body opaque to the roentgen rays and therefore it casts a shadow upon the film. When this shadow was first noted by roentgenologists, it was misinterpreted as being indicative of a pathological process—probably a tumor. As technique was improved this was found to be of normal occurrence.

Frequency of visualization of the pineal body roentgenologically has been determined in several rather large series of cases with a close correspondence in the figures. Thus, Naffziger, in an examination of 215 skulls, found the pineal body to be visualized in 45 per cent of all, 15.5 per cent of the pineal bodies of patients under twenty years of age being visualized and 58 per cent in those over twenty years of age. Vastine and Kinney, in an examination of 616 cases found the pineal body to be visualized in 47.9 per cent of all cases, 19 per cent of the cases under twenty years of age being visualized, and 52.2 per cent of those over twenty years of age. Visualization of the pineal body occurred in 46 per cent of females and 58 per cent of males. Dyke, in a survey of 3,000 consecutive skull examinations, found the pin-

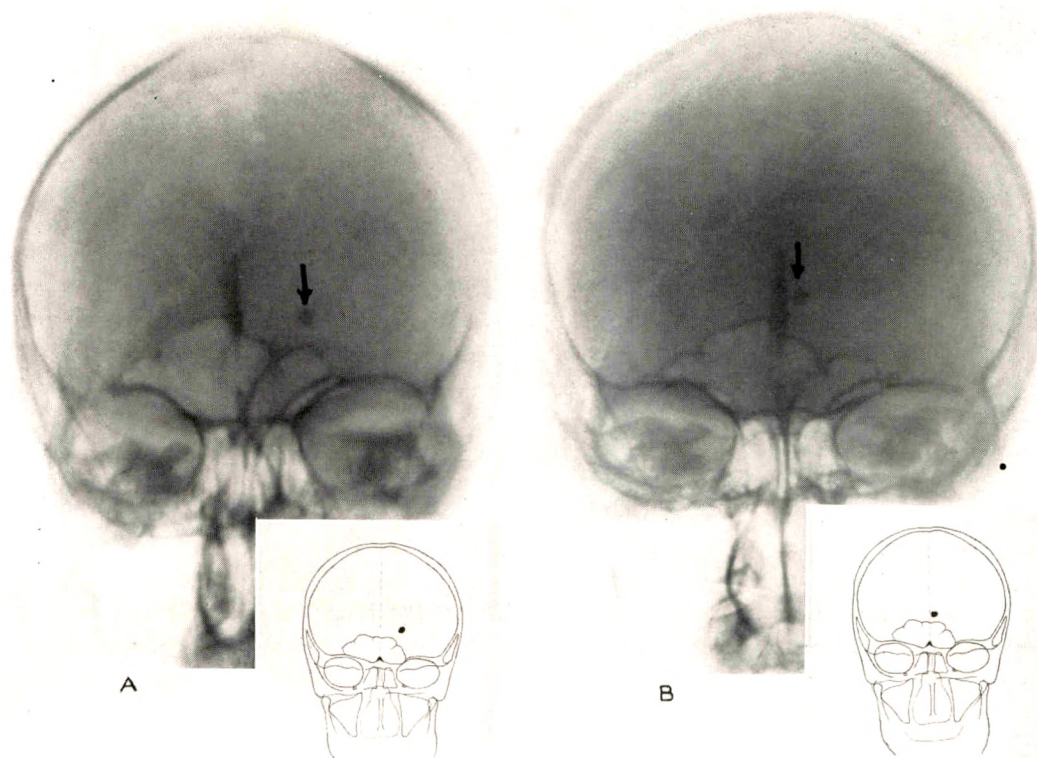


FIG. 1. A. Roentgenogram of a skull showing separation of the left lambdoid suture, a fracture extending into the left parietal bone, and displacement of the pineal body to the right indicating the presence of an extensive intracranial hemorrhage on the left side. B. Shows an operative defect in the skull on the left side. A large subdural clot was removed at operation. Following removal of the blood clot the pineal body has returned almost to its normal position in the midline.

pineal body to be visualized in 51 per cent of all cases, visualization occurring in 20 per cent of those under twenty years of age and in 59 per cent of those over twenty years of age. Of the males, 54 per cent visualization of the pineal body was found and of the females, 49 per cent. In a study of 86 cases, Beals found the pineal body to be demonstrable in 60.6 per cent of the cases, visualization being equally divided between males and females. Murphy found it visualized in over 40 of 100 consecutive cases.

The frequency of visualization of the pineal body is dependent upon the technique employed—the better the films, the more frequently the pineal body is visualized. Better average technical work is probably constantly being obtained and subsequent series of cases may be expected

to show a higher frequency of visualization than those previously reported.

Visualization of the pineal body per se is of no probable significance but a visible pineal body serves as a landmark which occupies a certain normal position, and occurrence beyond this normal range in position, with certain allowance for error which will be discussed later, is indicative of intracranial pathology causing displacement. The shadow of the pineal body normally is found in the midline. Occurrence of this shadow on either side of the midline in true anteroposterior or postero-anterior films represents displacement.

DISPLACEMENT

Schüller in 1918 was the first to call attention to the value of the position of the pineal body as a diagnostic aid, and cited



FIG. 2. Section of brain of same patient as shown in Figure 1. The calcified area is seen to be in the pineal body.

an unconfirmed case of lateral displacement from contraction due to softening from an old injury. Naffziger, in 1925, added 15 cases of lateral displacement of the pineal shadow which were confirmed by operation or autopsy. Vastine and Kinney, in 1926, reported on 23 cases which were verified by operation or post-mortem examination in which the pineal body had been reported as displaced laterally. These cases consisted of frontal, temporal, and parietal lobe gliomas and meningiomas. There was lateral displacement by an acoustic neuroma and lateral displacement to the opposite side in 2 cases of intracranial hemorrhage. I have recently observed a case which illustrates the diagnostic value of lateral displacement of the pineal body (Figs. 1 and 2). The patient was admitted in an unconscious condition following a fall.

Roentgenograms of the skull showed lateral displacement of the pineal body suggesting the presence of intracranial hemorrhage. An osteoplastic flap was removed and a large blood clot was evacuated. Re-examination showed the pineal

shadow to have returned almost to the midline. The case terminated fatally and the calcification was shown both microscopically and roentgenologically to be in the pineal body. These previous reports have dealt primarily with the value of lateral displacement of the pineal body from its normal midline position, in cases of tumor with displacement to the opposite side from that occupied by the tumor, in the presence of recent hemorrhage with displacement to the opposite side and in cases of atrophy due to previous trauma (Schüller), the displacement being by traction toward the side of atrophy.

Anteroposterior and Vertical Displacement

Schüller stated that the normal position of the pineal shadow in lateral roentgenograms of the skull was 1 cm. above a line joining the external auditory meatus and the lower border of the orbit, and 1 cm. posterior to the vertical plane, through the external auditory meatus. This range in position has not proved adequate in my rather limited experience. Naffziger, in 1925, said, "It is hoped that further observation and study may enable us so to standardize the lateral roentgenograms of the skull that we can detect an anterior or posterior or an up and down deviation of the shadow from its normal position." In 1926, Vastine and Kinney, working under the guidance of Sosman, at the Peter Bent

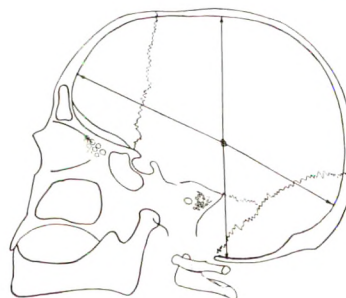


FIG. 3. Measurements are taken from the pineal body to: (1) the inner table of the frontal bone at its most distant point; (2) the inner table of the occiput at its most distant point; (3) the inner table of the vault; (4) the level of the base of the skull.

Brigham Hospital, in a series of 200 skull films showing calcification of the pineal body which were essentially negative for intracranial lesions attempted to establish a normal range in position on the lateral films of the skull.

Measurements were taken, as shown in Figure 3, from the pineal body to:

1. The inner table of the frontal bone at its most distant point.
2. The inner table of the occiput at its most distant point.
3. The inner table of the vault.
4. The level of the base of the skull.

In Chart 1, the measurement of the distance from the pineal body to the inner table of the frontal bone was plotted against the sum of the distances from the pineal shadow to the frontal bone and to the occiput—this sum is approximately equal to the greatest anteroposterior diameter of the skull. The pineal bodies of normal skulls were found to lie between the lines $a-a'$ and $b-b'$ which we considered the normal anteroposterior variation in position.

In Chart 2, the measurement from the pineal body to the inner table of the vault was plotted against the sum of the distances from the pineal body to the inner

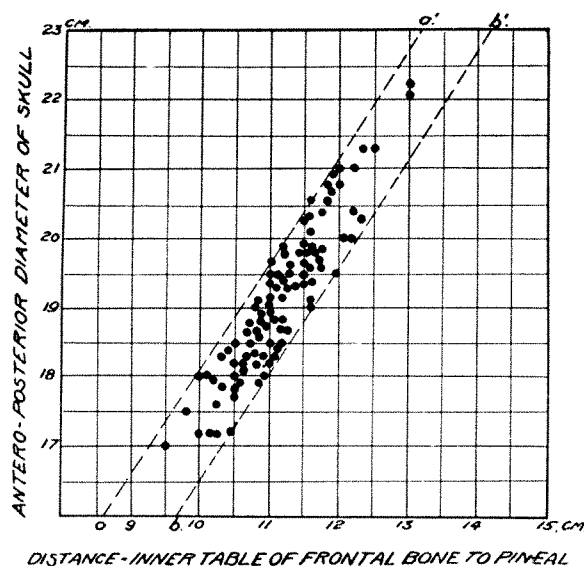


CHART 1.

table of the vault and to the level of the base of the skull—this sum is approximately equal to the vertical diameter of the skull. The pineal bodies of normal skulls were found to be between the line of $c-c'$

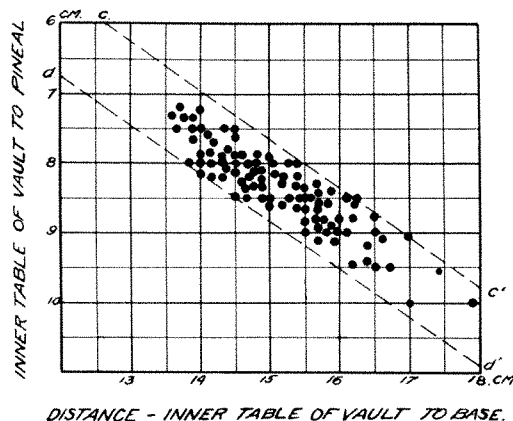


CHART 2.

and $d-d'$ which we considered the normal vertical variation in position.

Having thus established our normal curve it was considered that any pineal shadow lying to the left of the line $a-a'$ was displaced anteriorly, and to the right of $b-b'$ was displaced posteriorly, and any pineal shadow lying above the line $c-c'$ was displaced upward and any below the line $d-d'$ was displaced downward.

In order to estimate the value of pineal displacement, we studied the skull films of 268 cases of verified brain tumors of which 163 showed calcification of the pineal body.

Frontal Tumors. Posterior displacement of the pineal body was observed in 71 per cent of the frontal tumors with displacement occurring with about the same frequency in both gliomas and meningiomas.

Temporal Tumors. Posterior displacement of the pineal body was observed in 40 per cent of the temporal tumors and upward displacement was also observed in one case in which the lesion was low in the temporal region.

Parietal Tumors. Downward displacement was observed in 47 per cent of the

parietal tumors. Displacement is more apt to occur in meningiomas than in gliomas, the pineal body being displaced in 62 per cent of the parietal meningiomas and in 38 per cent of the parietal gliomas.

Occipital Tumors. Anterior displacement of the pineal body was observed in 44 per cent of the occipital tumors, dis-

Craniopharyngeal pouch tumors rarely displace the pineal body although displacement was observed in one case with a rather large tumor.

There was upward displacement in one case in which there was an aneurysm of the basilar artery measuring approximately 4 cm. in diameter.

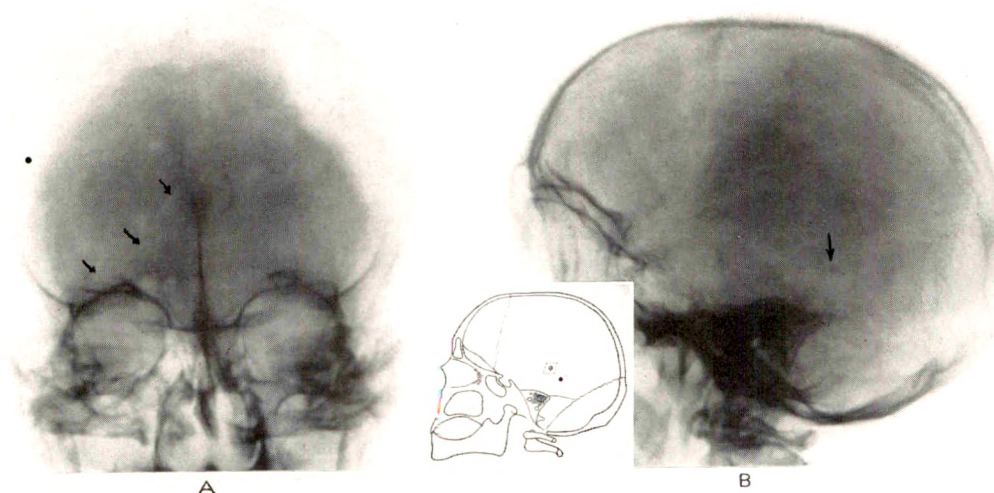


FIG. 4. A. Posteroanterior roentgenogram of a skull showing an enlarged meningeal channel in the left frontal region. B. Shows posterior and downward displacement of the pineal body. This with the enlarged meningeal channel permitted the roentgen diagnosis of a left frontal lobe tumor. This was confirmed at operation.

placement occurring with about the same frequency in meningiomas and gliomas.

Subtentorial Tumors. Upward displacement of the pineal body was observed in a third of the subtentorial tumors.

Acoustic neuromas and pituitary adenomas rarely displace the pineal body, displacement being observed in only 22 per cent and 10 per cent of these cases respectively.

Hydrocephalus per se was observed to produce a displacement of the pineal body in only 13 per cent of the cases. Camp has observed that cases of internal hydrocephalus often show a downward displacement of the pineal body. He calls attention to this as a possible source of error in diagnosing downward displacement as due to a parietal lesion when the disease is lower.

This work has been confirmed by Dyke at the Peter Bent Brigham Hospital where he comprehensively reviewed 494 cases of intracranial tumors of which number 253 had a roentgenologically demonstrable pineal body.

In regard to the value of displacement of the pineal or choroid plexus, Beals states that none of the patients in his series have had verified brain tumors, but it has been felt that the presence of these shadows in a normal position, in the few cases suspected of brain tumor, has added valuable evidence against the presence of tumor.

Displacement of the pineal body in the lateral film of the skull is illustrated in Figure 4. A diagnosis of left frontal lobe tumor was made roentgenologically from the presence of a unilateral prominence of a meningeal channel in the right frontal

region and from marked posterior displacement of the pineal body. This diagnosis was confirmed at operation.

SOURCES OF ERROR

Displacement of the pineal body is a distinct diagnostic aid in the localization of intracranial lesions. It is not a method of precision, however, and observation of pineal displacement, particularly when correlated with thorough clinical studies suggesting intracranial pathology, certainly indicates the presence of disease and warrants further roentgenological study by encephalography or ventriculography. The sources of error in diagnosing displacement of the pineal body are:

1. Roentgenograms made with the head in an improper position.
2. Unusual-shaped skulls, particularly dolichocephaly.
3. Unilateral calcification in the choroid plexus.
4. Calcification in tumors in the pineal region.
5. Shadows due to psammoma bodies, sandkörper, brain sand, phleboliths, etc.

1. There are commercial devices for keeping the head straight for the anteroposterior or posteroanterior films but these are unnecessary. Naffziger has used a stethoscope upon which there is a pointer for obtaining direct anteroposterior views. Sosman has employed a pelvimeter fitted with ear pieces and a long pointer. The ear pieces are placed in the patient's ears and the head rotated until the pointer is directed straight upward at the target of the tube. The head is then held in this position by means of a bandage. The head leveler described by Pfahler is an ingenious and practical device. A mechanical device is not absolutely necessary, however, as the head can usually be adjusted by standing at the end of the table and placing a finger in each of the patient's ears and rotating the head until the two fingers are equidistant from the table. Naffziger states that in anteroposterior or posteroanterior films of the skull, the pineal shadow is frequently obscured

by the nasal accessory sinuses. When the direction of the rays is parallel to a line drawn between the external canthus of the eye and the external auditory meatus, the pineal shadow is seen to be projected well above the sinuses. In the observation of displacement of the pineal body vertically, anteriorly, or posteriorly, it is important that true lateral views are examined. The sagittal plane of the head must be parallel to the film.

2. Unusual-shaped skulls as a source of error have been discussed by Dyke. He found slight anterior displacement, using the method of Vastine and Kinney, in 75 cases, all in dolichocephalic skulls. In most of these, he states, the displacement was very slight and probably was of no significance, and this was noted at the time the measurements were made. "It is felt that a figure well below 14 per cent represents a truer number of pineals outside of the usual range in normal skulls" (Dyke). This possibility of slight anterior displacement in dolichocephalic skulls must be kept in mind.

3. Unilateral calcification of the choroid plexus, although rare, must be remembered as a possible source of error in reporting lateral displacement of the pineal body. This is illustrated by the case reported by Pancoast before the Philadelphia Roentgen Ray Society in 1930. A small dense circular shadow was seen which closely resembled the appearance of the pineal body both in size and structure. This shadow was observed in a position lateral to the midline and suggested lateral pineal displacement, but this error in diagnosis was prevented by encephalography and the shadow was shown to be due to unilateral calcification in the choroid plexus.

There is no unanimity of opinion in regard to the frequency of roentgenologically demonstrable calcification in the choroid plexus. Thus, Dyke, in his series of 2,724 skull examinations found demonstrable calcification in 5.1 per cent of the cases, while Beals in a study of 86 cases found the choroid plexus to be demonstrable in 28 per

cent of the cases. He describes the shadows produced by the choroid plexus as a somewhat oval shadow about 1 cm. in diameter, without very sharply defined borders. The density is not uniform, the shadow giving the impression of many superimposed small dots and small curved shadows. The two shadows are seen exactly opposite each other, one on each side of the midline and separated by about 4 or 5 cm. When the pineal is also visualized, the three shadows stand at the angles of an isosceles triangle, the pineal at the obtuse apex anteriorly, the two choroid shadows at the angles of the base posteriorly. Camp has called attention to the importance of differentiating between calcification in the pineal body and the choroid plexus, particularly when this latter calcification occurs unilaterally. This differentiation is usually possible due to bilateral calcification of the choroid plexus, and due to its position above and posterior to that region usually occupied by the pineal body. The calcification of the choroid plexus is usually larger, is often crescentic in arrangement and is more mottled, though this differentiation is not always sufficient and, although rare, the possibility of unilateral calcification of the choroid must be borne in mind as a possible source of error in reporting pineal displacement. When the choroids as well as the pineal are demonstrable, this mistake cannot easily be made.

4. Calcification in tumors in the pineal region is usually more extensive than that seen in the pineal body. Lesions which may produce calcification in this region are gliomas, meningiomas, tuberculomas and teratomas. These are discussed under tumors of the pineal body (*vide infra*).

5. O'Sullivan has described 3 cases of calculi occurring in the brain in which there might be some confusion as to whether it was a displaced pineal body. These brain calculi are thought to be calcification in old scars or old hemorrhages. They were single, dense, sharply outlined shadows the size of a cherry stone. His illustrations show shadows which might be confused with a laterally displaced pineal body but

only one of the three cases was proved.

Calcification in aneurysms as reported by Sosman and Vogt occurs about the sella turcica and would not be confused with a pineal shadow. Calcification in parasitic cysts as reported in 2 cases by O'Sullivan as multiple, pea-sized, dense areas with irregular contours would not likely be confused with calcification in the pineal body. Calcified hematomas occurring within the brain have been described by Camp as irregular, dense, somewhat triangular shadows lying within the brain. These are larger and confusion with the pineal shadow is doubtful, since they are usually more laterally situated than the pineal body could possibly be.

TUMORS OF THE PINEAL BODY

Tumors of the pineal body are comparatively rare. Haldeman, in a comprehensive review of the literature, collected only 113 cases up to 1927. Elsberg, in a review of 767 cases of verified brain tumors from the New York Neurological Institute had only 2 pinealomas.

The classic contributions of Marburg, Krabbe, Tilney and Warren, Horrax and Bailey, and more recently Globus and Silbert, have shed much light on the pathogenesis of tumors arising in the pineal body, but there are many morphological features that are still obscure. The variability in structure is so great that a classification of these tumors into a single morphological group has been impossible. Krabbe has suggested the name pinealoma and this is probably as satisfactory as any offered thus far. The variability in morphology was shown in the review of the literature made by Haldeman in which the microscopic diagnoses were fibroma, psammoma, psammosarcoma, sarcoma, glioma, gliosarcoma, carcinoma, adenoma, adenocarcinoma, neuroglioma, neuroepithelioglioma, pinealoma, and pineoblastoma. Teratomas of the pineal body have been reported.

In regard to the *clinical aspects of tumors of the pineal body*, several authors have at-

tempted to summarize the symptoms that point to this condition. Discussing the diagnosis of pineal tumors in adults, Horrax states that, "In the presence of an intracranial pressure syndrome which simulates a cerebellar lesion, if there be added to the picture an involvement of one or both trochlear nerves together with recurring changes in the size of one or both pupils, and a tendency to spasticity in the lower extremities, a tumor of the pineal body should at least be suspected." Haldeman states that in preadolescent children a pineal tumor often produces the syndrome characterized by Pellizi as "macrogenitosomia praecox." Frankl-Hochwart says, "When one finds in a young individual, along with the general symptoms of tumor, as well as the local signs of a lesion of the corpora quadrigemina, abnormal body growth, unusual growth of hair, adiposity, somnolence, premature genital and sexual development, and finally intellectual maturity, one must think of pineal tumor." Probably the most significant of the eye signs are paralysis of upward movement, diplopia, abducens paralysis, ptosis, and absence of the light reflex (Haldeman).

Only a few of these tumors have been localized to the pineal body ante mortem. These observations have been reported by neurosurgeons or neuropathologists on cases in which the diagnosis was made only at the operating table or at the post-mortem examination. For this reason the literature contains few references to the roentgenologic findings. There is no reference to the occurrence of roentgenologically demonstrable calcium in the true pinealoma or pineoblastoma. Teratomas sometimes contain calcium (Sosman). The presence of calcification may be a diagnostic point by which teratomas may be differentiated from pinealomas (Horrax and Bailey), although in their only case of teratoma of the pineal body no calcification was seen. Altmann recently reported a dermoid arising from the pineal body in a boy eleven years of age, in which the diagnosis was

made from the presence of a calcified tumor of the pineal body.

The presence of increased intracranial pressure with the production of an internal hydrocephalus can readily be understood by the roentgenologist when the position of the pineal body near the aqueduct of Sylvius is borne in mind. In the presence of the above symptoms the roentgenologist should search carefully in the region of the pineal for calcification. This will sometimes be seen in teratomas and dermoids.

Ventriculograms will show a blocking of the aqueduct of Sylvius with a resulting internal hydrocephalus. A defect may be observed in the posterior portion of the third ventricle due to the presence of the pineal tumor.

Encephalograms are of little positive value in the diagnosis of pineal tumors since air cannot enter beyond the fourth ventricle. Furthermore because of the increased intracranial pressure, the procedure is contraindicated.

Arteriography may be of value, as illustrated by the case of Egas Moniz, Pinto and Almeida Lima, in which a diagnosis of glioma in the pineal region was made by this measure and the findings confirmed by operation.

Gliomas, meningiomas, and tuberculomas are the lesions occurring in this region which must be differentiated from pineal tumors.

Gliomas usually are on one side or the other, rarely arising from the pineal region, although Horrax and Bailey have reported spongioblastomas arising from the pineal body. Calcification in gliomas frequently occurs (12.9 per cent—Mason; 11 per cent—Sosman; 5 per cent—Camp; 13.5 per cent—Van Dessel), and therefore when occurring as a midline tumor in the pineal region may be confused with calcified tumors of the pineal region. The presence of a calcified pineal body which seems to be of normal size will make one suspect a tumor in this region of *other* origin, particularly if the pineal body is seen to be displaced.

Meningiomas arising from the pineal region have been observed. Elsberg, in a review of 767 verified tumors of the brain, found 13.2 per cent to be meningeal fibroblastomas of which only a fourth could be regarded as parasagittal, and examination of his illustrations shows that relatively few of these are in a position where they would be confused with tumors of the pineal body. These parasagittal meningiomas usually arise from the meninges of one side or the other, rarely being midline tumors. Sosman believes that it is impossible to differentiate between a glioma and meningioma from the character of the calcification to be seen in the roentgenograms, unless, of course, the calcification in a meningioma is adjacent to the skull and characteristic spicule formation and perforating vessels are seen. Masson could observe no distinguishing difference between calcification in gliomas and meningiomas. "From the character of the calcification it is seldom possible to differentiate with certainty between the

visible evidence of lime salt deposit in a gliomatous growth and the results of a similar process in an area of degenerated brain as a result of vascular changes, or in an old calcified brain abscess" (Masson). I know of no definite characteristics which would serve to differentiate the calcification in the above conditions from that in calcified tumors of the pineal body. Kingreen described a few cases in which calcification was observed in tuberculomas, but no distinguishing difference in the calcification was described by which that condition could be differentiated from a calcified pineal tumor.

SUMMARY

Displacement of the pineal body has been discussed and illustrated.

Evaluation of pineal displacement as a diagnostic aid and the possible sources of error have been considered.

The literature relative to pineal tumors has been reviewed.

REFERENCES

1. ALTMANN, F. Ueber ein Dermoid der Zirbeldrüse. *Wien. klin. Wchnschr.*, 1930, 43, 108-111.
2. BAILEY, P., and CUSHING, H. A Classification of Tumors of the Glioma Group on a Histo-genetic Basis. J. B. Lippincott Co., Philadelphia, 1926.
3. BEALS, J. A. Intracranial calcification, probably of the choroid plexus. *Radiology*, 1930, 15, 268-273.
4. BERBLINGER. In: Henke and Lubarsch. Handbuch der speziellen path. Anatomie und Histologie, Vol. 8, pp. 681-759.
5. CAMP, JOHN D. Roentgenological manifestations of intracranial disease. *Radiology*, 1929, 13, 484-493.
6. CAMP, JOHN D. Intracranial calcification and its roentgenologic significance. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1930, 23, 615-624.
7. CAMP, JOHN D. Personal communication.
8. DANA, CHARLES L. Text-Book of Nervous Diseases, Wm. Wood & Co., New York, 1921.
9. DYKE, C. G. Indirect signs of brain tumor as noted in routine roentgen examinations; displacement of the pineal shadow. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1930, 23, 598-606.
10. EGAS MONIZ, PINTO, A., and ALMEIDA LIMA. Tumeur de la glande pinéale irriguée par un seul des groupes sylviens. *Rev. neurol.*, 1930, 2, 51-54.
11. ELSBERG, C. A. Parasagittal meningeal fibroblastomas. *Bull. Neurol. Inst. N. York*, 1931, 1, 389-418.
12. GLOBUS, J. H., and SILBERT, S. Pinealomas. *Arch. Neurol. & Psychiat.*, 1931, 25, 937-985.
13. GLOBUS, J. H. Tumors of quadrigeminate plate. *Arch. Ophth.*, 1931, 5, 418-444.
14. HALDEMAN, K. O. Tumors of the pineal gland. *Arch. Neurol. & Psychiat.*, 1927, 18, 724-754.
15. HORRAX, G. Differential diagnosis of tumors primarily pineal and primarily pontile. *Arch. Neurol. & Psychiat.*, 1927, 17, 179-192.
16. HORRAX, G., and BAILEY, P. Tumors of the pineal body. *Arch. Neurol. & Psychiat.*, 1925, 13, 423-470.
17. KINGREEN, OTTO. Verkalkte Gehirn-Conglomerattuberkeln im Röntgenbilde. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1924, 32, 55.
18. KRABBE, K. H. Anat. Hefte, 1916, 54, 191.
19. MARBURG, O. Zur Kenntnis der normalen und pathologischen Histologie der Zirbeldrüse; die Adipositas cerebialis. *Arb. a. d. neurol. Inst. a. d. Wien. Univ.*, 1908, 17, 217-279.
20. MASSON, C. B. Occurrence of calcification in gliomas. *Bull. Neurol. Inst. N. York*, 1931, 1, 314-327.

21. MURPHY, J. T. Intracranial calcifications. *Radiology*, 1928, 11, 213-216.
22. NAFFZIGER, H. C. A method for the localization of brain tumors—the pineal shift. *Surg., Gynec. & Obst.*, 1925, 40, 481-484.
23. O'SULLIVAN, JOHN. Some rarer intracranial calcifications and ossifications. *Brit. J. Radiol.*, 1925, 30, 295-304.
24. PANCOAST, H. K. Personal communication.
25. PFAHLER, G. E. *Arch. Radiol. & Electroth.*, 1916, 193-196.
26. PIERSOL, GEORGE A. Human Anatomy. J. B. Lippincott Co., Philadelphia, 1919.
27. DEL RIO HORTEGA, P. *Arch. d. neurobiol.*, 1922, 3, 359.
28. DEL RIO HORTEGA, P. *Arch. espan. de oncol.*, 1930, 1, 297.
29. SCHÜLLER, ARTHUR. Roentgen Diagnosis of Diseases of the Head. C. V. Mosby Co., St. Louis, 1918.
30. SOSMAN, M. C. Radiology as an aid in the diagnosis of skull and intracranial lesions. *Radiology*, 1927, 9, 396-404.
31. SOSMAN, M. C., and PUTMAN, T. J. Roentgenological aspects of brain tumors—meningiomas. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1925, 13, 1-12.
32. TILNEY, F., and WARREN, L. F. A contribution to the study of the epiphysis cerebri with an interpretation of the morphological, physiological and clinical evidence. *Am. Anat. Mem., Phila.*, 1919, No. 9, 7-257.
33. UEMURA, S. Zur normalen und pathologischen Anatomie der Glandula pinealis des Menschen und einiger Haustiere. *Frankfurt. Ztschr. f. Path.*, 1917, 20, 381-488.
34. VAN DESSEL, A. L'incidence et le processus de calcification dans le gliomes du cerveau. *Arch. franco-belges de chir.*, 1925, 28, 845-874.
35. VASTINE, J. H., and KINNEY, K. K. The pineal shadow as an aid in the localization of brain tumors. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1927, 17, 320-324.



THE ROENTGEN FINDINGS IN SUPPURATION OF THE PETROUS APEX (PETROSITIS)*

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UNTIL recently the diagnosis of suppuration of the petrous apex was not usually made except after post-mortem examination, and even today in spite of the graphic roentgen demonstration of this change in the petrous bone there are still clinicians who do not recognize its clinical significance.

Petrositis, or suppuration in the apical portion of the petrous pyramid, is a clinical entity. It is a complication of an acute otitic infection, and usually follows an acute coalescent mastoiditis. Petrosal suppuration may occur in a diploic bone or in a pneumatic bone. The suppuration in the former type of bone is an osteomyelitis, while a suppuration in the latter type produces changes which are analogous to a suppurative lesion in a well-pneumatized mastoid process. This paper will be limited to the study of petrositis as it occurs in a pneumatic bone.

Pneumatization of the temporal bone is the normal process in development. There is considerable variation in the character and extent of pneumatization. When pneumatization is extensive, cells are found occupying portions of the squamosa and occipital bones, around the mouth of eustachian tube, floor of middle ear, tegmen tympani, petrous pyramid and petrous apex. Siebenmann, Girard, and many others, have described tracts of cells leading into the petrous apex from the middle ear. Pneumatization in the petrous tip varies considerably. One or two large pneumatic cells may be present (Collet, von Troelisch, Merkel).

Mangabeira-Albernaz, Profant, Burger, Freckner, Jungert, and others, believe that an infection in these cells (petrous apex) is the cause for the so-called Grad-

enigo syndrome. Bigler demonstrated roentgenologically an abscess of the petrous apex, which he believed was the cause of Gradenigo's syndrome. Eagleton describes caries of the petrous apex with sixth nerve involvement.

In a series of 15 cases of petrous suppuration, which were under the observation of Kopetzky and Almour, but 2 cases showed a sixth nerve paralysis. This would tend to indicate that an abducens palsy is not a constant concomitant of petrous suppuration. Further, Kopetzky and Almour quote and agree with Vogel and others, who do not consider the so-called Gradenigo syndrome as a clinical entity or characteristic of a specific lesion. Jungert confuses the two conditions for he speaks of the Gradenigo syndrome with and without petrous suppuration. He claims that the cases which recover do not have petrous suppuration; that these cases showing clinical and roentgenological evidences of petrous suppuration must be operated upon and that the simple or radical operation is inadequate and that measures must be instituted to drain the petrous apex even if the labyrinth is to be sacrificed. He also cites 4 cases of otitic meningitis wherein at autopsy the cause in all 4 cases was found to be an empyema of the petrous apex; yet in none of these cases was a sixth nerve paralysis present. It seems clear that the diagnosis in vivo was not made because of the preconceived belief that a sixth nerve paralysis (Gradenigo's syndrome) is the essential for the recognition of the clinical and pathological entity of suppuration in the petrous apex.

It is of the utmost importance to understand that a petrositis may exist without sixth nerve palsy. Sears states: "Pathology

* From the Department of Roentgenology, Beth Israel Hospital, New York City (Dr. I. S. Hirsch, Director). Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

of the petrous bone in otogenic paralysis of the abducens, as observed by careful autopsy is slight in quantity, covering all autopsy records available. However, the material at hand is not too convincing; to offset the abscess cavities at the petrous tip there are others to match them in which no paralysis existed." Only by realizing this fact will measures be instituted promptly to drain the focus in the petrous apex and prevent a meningitis in such cases wherein the clinical signs and roentgenological evidences of the disease are present. These cases fall into two groups: petrous suppuration with and without adequate drainage.

Petrous Suppuration with Inadequate Drainage. The usual history is that of a simple mastoidectomy upon an extensively pneumatized temporal bone with an apparently normal convalescence. After a few days the temperature reaches normal, the aural discharge gradually diminishes and disappears, and the wound is practically healed. This is followed by an interval of well being which varies from a few days to several weeks. There is usually a sudden onset of pain in or about the eye, particularly retro-orbital, which is the first typical symptom, and occurs on the same side as the suppurative lesion. This is due to irrita-

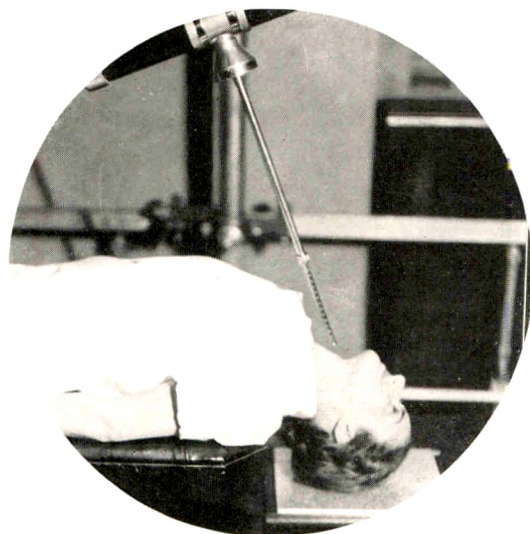


FIG. 1. Position of patient. Inferosuperior projection of base of skull.

tion about the Gasserian ganglion, more particularly the ophthalmic branch of the fifth nerve. Eagleton attributes the retro-orbital pain to an inflammatory reaction of the dura overlying the diseased petrous

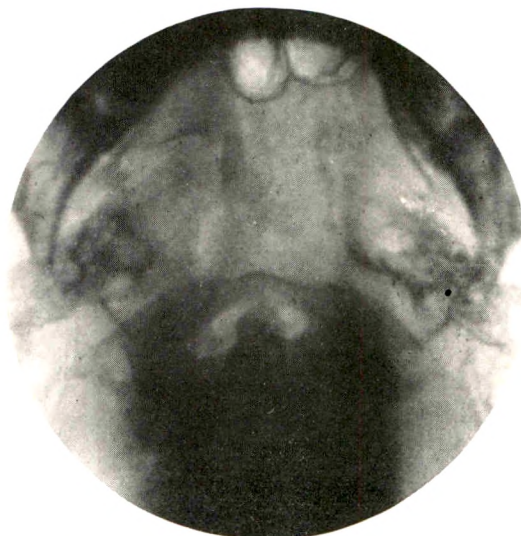


FIG. 2. Intense atrophy and loss of trabeculations in the left petrous apex. Suppuration in the petrous apex with inadequate drainage.

tip. As a rule, there is a sudden profuse otorrhea accompanying the eye pain. Associated with these symptoms is a low grade temperature. A roentgenographic examination at this time shows evidences of petrosal tip suppuration. Operative interference is indicated in the presence of the above symptomatic group with positive roentgen findings. Eagleton says that retro-orbital pain in the presence of a sepsis means caries of the petrous apex. Delay results in endocranial extension to the meninges with a fatal termination. It is of importance to note that the presence of a sixth nerve paralysis is not a necessary factor in diagnosis.

Petrous Suppuration with Adequate Drainage. The history is usually the same as the aforementioned type; a normal convalescence after a mastoidectomy. There is, however, no typical eye pain and there is no development of sepsis. The important clinical factor is the return or continuance of a profuse otorrhea, which is persistent

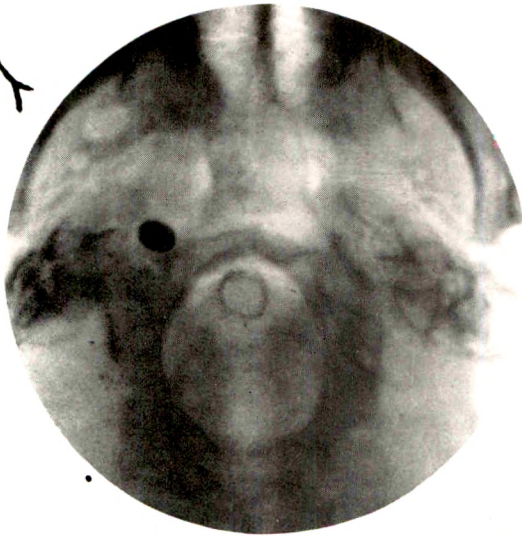


FIG. 3. Considerable destruction of the left petrous apex. Extradural extravasation of lipiodol. Suppuration in the petrous apex with inadequate drainage.

following mastoidectomy on an extensively pneumatized bone. The roentgenographic examination shows changes characteristic of petrous suppuration.

This condition, if the petrous apex is drained, resolves and heals completely; if not operated upon a protracted otorrhea results, due to continuous drainage through broken down cells or through a fistulous tract into the middle ear.

Friesner and Druss state that in these cases recovery is an evidence of a mild infection and adequate drainage. Kopetzky and Almour, however, maintain that the virulence of the infection is of no consequence and that adequate drainage is the all-important factor. Frenckner quotes Voss, who claims that pus foci in the pyramids have a tendency to heal if the tympanum and antrum are well drained. Uffenorde states that one must think of a pyramidal tip suppuration where the middle ear continues discharging after surgery for the relief of an acute mastoid suppuration.

TECHNIQUE

For the demonstration of suppuration in the petrous apex, the most information is obtained from a film of the base of the skull,

because both pyramids are depicted at the same time, and are contrasted by the surrounding bony structures and show their structural character and detail more clearly.

The routine examination of the mastoid processes includes one view of the base of the skull. Should a complicating petrous suppuration develop, the original film of the petrosae is available for comparison with subsequent films permitting the detection of the earliest changes.

Figure 1 shows the position of the patient. The patient is supine, the head is lower than the rest of the body and rests on the vertex, so that a line drawn through the external auditory canal and superior orbital margin is parallel to the cassette, which is horizontal. The sagittal plane of the head is perpendicular to the table. The tube is tilted upward 15 degrees. The central ray is directed one inch in front of the external auditory canal, in the midline. The same position can be accomplished by hyperextending the body, using books or a block as a support in the mid and lower dorsal regions. A small pillow is used to cover the block, the elevation being about 8 inches.

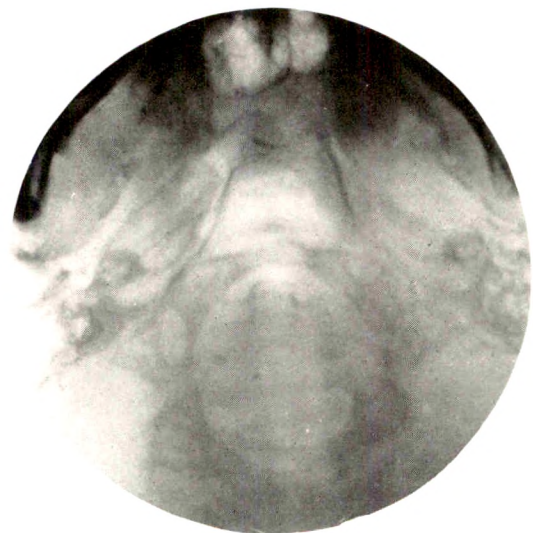


FIG. 4. Intense atrophy of the right petrous apex. No operative interference subsequent to mastoidectomy. Patient is symptom-free except for otorrhea. Suppuration in the petrous apex with adequate drainage.

INTERPRETATION

The value of the roentgen diagnosis lies entirely in the fact that suppuration of the petrous apex can be recognized before the development of meningeal infection, and in sufficient time for surgical drainage to be instituted.



FIG. 5. Bilateral mastoidectomy six years ago. Right side healed. Persistent discharge from left side. Left petrous apex shows a diminution in aeration and thickened trabeculae.

similar to a diminution in aeration of a pneumatic mastoid such as is found in an otitis media.* This change is not due to petrositis. None of our cases showed any changes of a suppurative petrositis until some time after a mastoidectomy had been performed. This, however, does not pre-

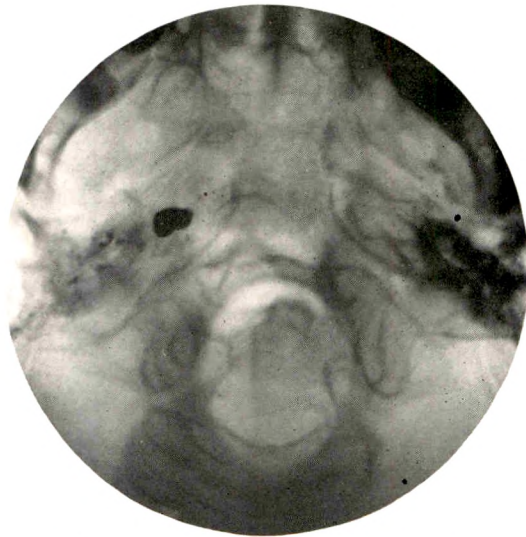


FIG. 6. Same as Figure 5. Revision operation with injection of lipiodol into mastoid antrum. The lipiodol extended into the petrous apex through tract of cells above labyrinth.

As previously stated, a film of the base of the skull is routinely made in all mastoid examinations. This has been of inestimable value in these cases which subsequently developed a petrositis.

Arnoldson, in a discussion of Hellmer's paper, cites 7 cases of otogenic meningitis which, at autopsy, showed the source to be a suppuration of cells in the petrous apex. He stresses the value of determining roentgenologically the presence of pneumatization in the petrous apex in all cases of otitic suppuration prior to mastoidectomy. Only in this way, he believes, can one be on the lookout for a possible complication in the petrous apex.

In all cases of suppurative mastoiditis, the petrous pyramid shows a generalized diminution in aeration. This change in aeration is due to a congestion of the membrane lining the air spaces. The finding is

clude the possibility of its presence before a mastoidectomy. Further study of this original film shows the character and extent of the pneumatization in the pyramid. It is readily compared with the opposite petrous pyramid. In the event of a bilateral otitic infection, both pyramids would show similar changes, and the subsequent development of petrositis on one side or the other would be readily detected.

A roentgenographic examination at the time when a petrositis has developed shows decalcification of the bony trabeculae which subsequently disappear. This is followed by decalcification or atrophy of the entire apical portion, the contour remaining intact. The atrophy may be so intense that the petrous apex is either faintly or not at

* Geyman and Clark divide petrositis into three groups: occurring with acute otitis media, with acute mastoiditis, and as a postoperative sequel.

all visualized. Perforation and finally destruction of a considerable portion of the apex may ensue. This atrophy or decreased density is found only internal and anterior

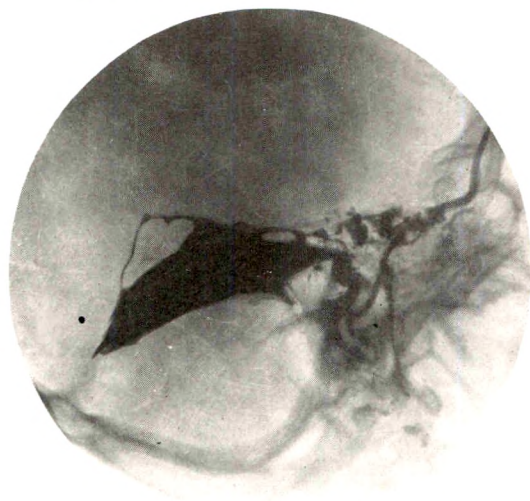


FIG. 7. Petrous suppuration with inadequate drainage; patient died of meningitis. Lipiodol injected into petrous apex, post mortem. The lipiodol extends posteriorly above the tentorium and into the anterior and middle cranial fossae.

to the labyrinth. The basal portion of the pyramid retains its density. By contrast, the basal portion of the pyramid shows a relative increase in density, which is only apparent and not real. Operative interference is imperative in the presence of clinical symptoms and the above findings.

Cases of petrous suppuration with adequate drainage also show positive roentgen findings, although clinical symptoms may be absent. These cases should be operated upon to eradicate the focus of infection in the petrous apex. If not operated upon it will be the cause for a protracted otorrhea.

The petrous bone in a case with a protracted otorrhea shows a generalized diminution in aeration. There is no atrophy. The apical contour is intact. The trabeculae are not distinctly visualized, and may be destroyed; or the trabeculae may be thickened. The basal portion of the pyramid shows a productive osteitis.

In 6 cases lipiodol was injected into the petrous apex. In 5 cases the injection was

made either through the fistulous tract or the operative opening into the tip. In the sixth case the lipiodol was injected into the middle ear (Gottlieb).

One case, which died from a purulent leptomeningitis, showed the spread of the lipiodol into the anterior cranial fossa, across the middle fossa, and over the tentorium. This outlined the pathway of infection, which was through the petrous apex.

Another case with no meningeal symptoms showed the lipiodol in the petrous apex and in the cranial cavity above the tentorium. This patient presented a typical clinical picture for several weeks but it apparently was not recognized. Roentgenographic examination showed changes of petrous suppuration, and immediate operation was advised. Timely operation probably prevented the development of a meningitis. The patient is alive today, and on the road to recovery, but is still in the hospital.

In one case which showed marked apical destruction the lipiodol escaped from the petrous apex subdurally into the region of the inferior petrosal sinus. Seven months

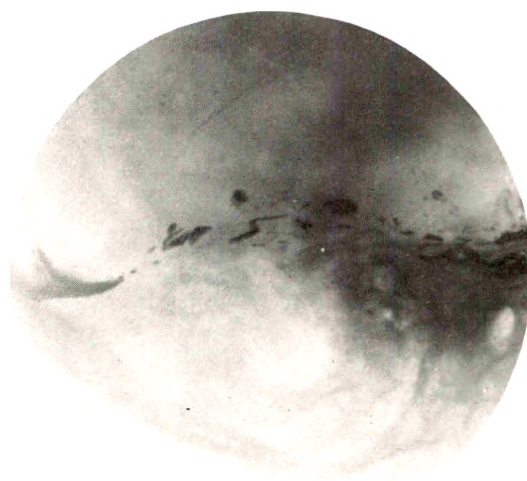


FIG. 8. Petrous suppuration with inadequate drainage, right side. No meningeal symptoms. The petrous apex was drained and lipiodol injected. The distribution of the lipiodol is the same as in Figure 7. Timely operation prevented the development of a meningitis.

later the lipiodol was fragmented but in the same location. In the other 3 cases the droplets of lipiodol were confined to the petrous apex.

One case in which the entire tip was not visualized due to the intense atrophy showed the lipiodol confined entirely within the apex. There was no extravasation subdurally. This failure to visualize the borders of the petrous apex is not an indication that a perforation through the apex has occurred. Roentgen examination two weeks later showed the lipiodol in the petrous apex, but the size of the lipiodol shadow was smaller. A part of the lipiodol must have drained through the middle ear.

The injection of lipiodol into the petrous apex, as practiced by Kopetzky and Almour at the time of operation or shortly thereafter, is not attended by any untoward sequelae.

In one case, with a persistent discharge from the wound, lipiodol injected into the middle ear at a revision operation depicted the tract of infection above the labyrinth and into the petrous apex.

Roentgen examination of several of the operatively cured cases of petrous suppuration, six months to one year postoperative, show a return to normal density of the apical portion, with an increase in density in the perilabyrinthine area or basal portion due to a productive bone change. The typical bony cell walls do not reform.

SUMMARY

1. Suppuration in the apical portion of the petrous pyramid is a complication of

an acute otitic infection, and can be recognized clinically and roentgenologically. Sixth nerve paralysis, in cases of petrous suppuration, is by no means an important or essential finding; it may be a coincidental finding with a lesion in the pyramid, and again the petrous pyramid may be extensively involved without any signs of involvement of the sixth nerve.

2. The clinical recognition depends upon the following:

- a. Profuse otorrhea, occurring after a period of cessation, following a simple mastoidectomy.
- b. Pain along the distribution of the ophthalmic branch of the fifth nerve, retro-orbital.
- c. Low grade sepsis.

3. The roentgen findings are diminished aeration, deficient trabeculations, intense atrophy, perforation and finally destruction of the apical contour. These changes occur only in pneumatized petrous pyramids.

4. Operative interference is indicated when clinical symptoms and roentgenological findings are present.

5. Cases showing roentgenological findings and no clinical symptoms have adequate drainage, and, if not operated upon, will probably terminate in a protracted otorrhea.

6. The roentgenologic findings in lesions of the petrous pyramid in other than pneumatized bones are not discussed in this paper since they constitute a different lesion.

REFERENCES

1. ALMOUR, RALPH. Empyema of petrous apex; operation; recovery. *Ann. Otol., Rhin. & Laryng.*, 1932, 41, 405-411.
2. ARNOLDSON. Discussion. *Acta oto-laryng.*, 1931, 16, 248-249.
3. BALDENWECK. Étude anatomique et clinique sur les relations de l'oreille moyenne avec la pointe du rocher, etc. Thèse de Paris, 1908.
4. BIGLER, MAX. Zur röntgenologischen Darstellung eines Knochenabscesses in der Felsenbeinspitze beim Gradenigoschen Symptomenkomplex. *Ztschr. f. Hals-, Nasen- u. Ohrenh.*, 1930, 25, 249-255.
5. BURGER, H. Die röntgenologische Diagnose des Syndroms von Gradenigo. *Acta oto-laryng.*, 1932, 17, 353-361.
6. COLLET, F. -J. Pneumatisation de la pointe du rocher. *Arch. internat. de laryngol.*, 1923, 29, 449-451.
7. EAGLETON, W. P. Localized bulbar cisterna (pontile) meningitis, facial pain and sixth nerve paralysis and their relation to caries of the

- petrous apex. *Arch. Surg.*, 1930, 20, 386-420.
8. EAGLETON, W. P. Unlocking of the petrous pyramid for localized bulbar (pontile) meningitis secondary to suppuration of petrous apex; report of four cases with recovery in three. *Arch. Otolaryng.*, 1931, 13, 386-422.
 9. FRENCKNER, PAUL. Some remarks on the treatment of apicitis (petrositis) with or without Gradenigo's syndrome. *Acta oto-laryng.*, 1932, 17, 97-120.
 10. FRIESNER, I., and DRUSS, J. G. Osteitis of the petrous pyramid of the temporal bone, associated with paralysis of external rectus. *Arch. Otolaryng.*, 1930, 12, 342-365.
 11. GEYMAN, M. J., and CLARK, D. M. The roentgen demonstration of petrositis. *Acta radiol.*, 1932, 13, 125-133.
 12. GIRARD, L. Perilabyrinthine cells. *Sec. de laryngol., d'otol. et de la rhinol. de Paris*, Dec. 9, 1911.
 13. JUNGERT, Y. Einiges über das Syndroma Gradenigo und die Erfahrungen darüber and der Klinik auf Sabbatsberg. *Acta oto-laryng.*, 1931, 16, 394-403.
 14. KOPETZKY, S. J., and ALMOUR, R. The suppuration of the petrous pyramid; pathology, symptomatology and surgical treatment. *Ann. Otol., Rhin. & Laryng.*, 1930, 39, 996; 1931, 40, 157; 396; 922.
 15. LILLIE, H. I., and WILLIAMS, H. L. Suppuration of the petrous pyramid. *Arch. Otolaryng.*, 1932, 15, 692-696.
 16. MANGABEIRA-ALBERNAZ, P., Grande cellule pneumatique du rocher. Contribution à la pathogénie du syndrome de Gradenigo. *Arch. internat. de laryng.*, 1929, 35, 1034-1050.
 17. MERKEL, FR. S. Handbuch der topographischen Anatomie zum Gebrauch für Aerzte. Braun-schweig, 1891, Vol. I, p. 561.
 18. PROFANT, H. J. Gradenigo's syndrome, with a consideration of "petrositis." *Arch. Otolaryng.*, 1931, 13, 347-378.
 19. SEARS, W. H. Otogenic paralysis of the abducens with especial mention of isolated palsy associated with irritation of the Gasserian ganglion. *Tr. Am. Laryng. & Otol. Sec.*, 1925, p. 89.
 20. SIEBENMANN, F. Mittelohr und Labyrinth. Handbuch der Anatomie des Menschen. Herausgegeben von K. von Bardeleben. Vol. V, part 2, Jena, 1897.
 21. TAYLOR, H. K. Roentgen findings in suppuration of the petrous apex. *Ann. Otol., Rhin. & Laryng.*, 1931, 40, 367-395.
 22. v. TROELISCH. Lehrbuch der Ohrenheilkunde. Seventh edition. 1881, p. 191.
 23. UFFENORDE. Zur Klinik der Fälle von Mittelohr-Eiterung mit tiefen Perilabyrinthären Herden. *Arch. f. Ohren.-Nasen- u. Kehlkopf.*, 1919-1920, 105, 87-131.



THE ROENTGEN DIAGNOSIS OF SPINAL DEFORMITIES

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IT IS the purpose of this discussion to present the various diseases which, when they affect the spine, may result in deformity of vertebral bodies; to classify these diseases; to describe the roentgen appearance of the vertebrae under these various conditions with special regard to differential diagnosis; and finally to present a bibliography limited to the more or less recent or easily accessible literature to serve as a reference guide to those interested in any particular phase.

CLASSIFICATION

Congenital Anomalies:^{31, 40, 42, 51, 101, 113, 137, 147}

1. Absence of half or all of the vertebral body: Klippel-Feil syndrome.
2. Vertebral fusion: complete, unilateral, cross fusion.
3. Supernumerary vertebra.
4. Supernumerary ribs.
5. Hemihypertrophy.

Developmental Disorders:^{23, 32, 51, 52, 61, 68, 82, 106, 125, 141}

1. Retropulsion of the nucleus pulposus.
2. Kyphosis dorsalis juvenilis; osteochondritis; epiphysitis; subchondral necrosis.^{19, 24, 86, 122, 149}
3. Osteogenesis imperfecta.
- *4. Local malacias; presenile osteoporosis.¹¹⁰
5. Chondrodystrophy.^{130, 139}
6. Dwarfism.¹¹⁹

Trauma:

1. Fracture with or without dislocation.
2. Kummell's disease; Kummell-Verneuil's disease.^{73, 74, 75, 76, 77}

Infections:

1. Osteomyelitis
 - (a) *Staphylococcus aureus*.^{2, 13, 27, 54, 80, 88, 105, 114, 135, 145} (Fig. 1A, B, C).
 - (b) *Pneumococcus*.⁹²
 - (c) Cerebrospinal meningitis.¹¹
 - (d) Typhoid.^{3, 5, 9, 50, 89, 98}
 - (e) Typhus.⁵⁸
 - (f) Malta fever.^{25, 116, 126}
 - (g) *Brucella abortus*.^{62, 78}
 - (h) Grippe.¹⁷
 - (i) Smallpox.²⁸

* These conditions are arbitrarily so classified. Revision may be needed with the acquisition of further knowledge

(j) Leprosy.⁶⁶

(k) *B. proteus* (personal experience).

2. Tuberculosis.^{33, 31, 42, 127, 136}
3. Syphilis.^{1, 23, 29, 57, 142, 148} (Fig. 2).
4. Charcot's spine.^{83, 103, 141}
5. Fungous infections.^{14, 26, 96, 104, 111, 129}
6. Echinococcus disease.^{12, 55, 79, 146}

Metabolic Disorders:

1. Hunger osteopathy.⁶¹
2. Osteomalacia.^{23, 51, 61, 71}
3. Osteitis fibrosa cystica.^{7, 39, 124, 138}
4. Osteitis fibrosa (Paget's).⁴²
5. Pituitary disease.⁹⁷
6. Amyloid disease.^{4, 37, 85, 123} (Fig. 3).
7. Gaucher's disease;^{16, 59, 107, 108, 143} Schüller'-Christian's syndrome; Niemann-Pick's disease¹⁰⁹ (Fig. 4).
8. Gout.⁸¹

Blood Dyscrasias:^{41, 43, 67, 90, 118}

1. Leucemia (Fig. 5).
- *2. Chloroma.

Primary Tumors:^{41, 43, 61}

1. Giant cell tumor.^{30, 81, 120}
2. Sarcoma; chondromyxosarcoma.^{67, 69, 112, 117, 133, 144}
3. Ewing's tumor.
4. Myeloma.^{8, 10, 36, 44, 102, 131}
5. Angioma.^{6, 20, 47, 49}
6. Chordoma.⁶⁰
- *7. Radium osteitis (Martland).⁸⁷

Metastatic Tumors:^{41, 56, 64, 66, 93, 128}

1. Carcinomas of lung, thyroid, gastrointestinal tract, nasopharynx, breast, prostate, liver.^{15, 22, 38, 53, 61, 66, 94, 131, 132}
2. Hypernephroma.^{35, 46, 100}
3. Neurofibroma.^{18, 91}
4. Rhabdomyoma.²¹
5. Sarcomas, as, for example, of liver (personal experience).

Unclassified:

- *1. Hodgkin's disease and lymphosarcoma.^{45, 70, 72, 95, 115}

Pressure Atrophy:

1. Aneurysm.¹²¹
2. Extravertebral tumor (personal experience).

Congenital Anomalies. This group of spinal deformities is a difficult one to analyze except in the light of embryological studies. The vertebrae in their development are formed by the union of the ad-

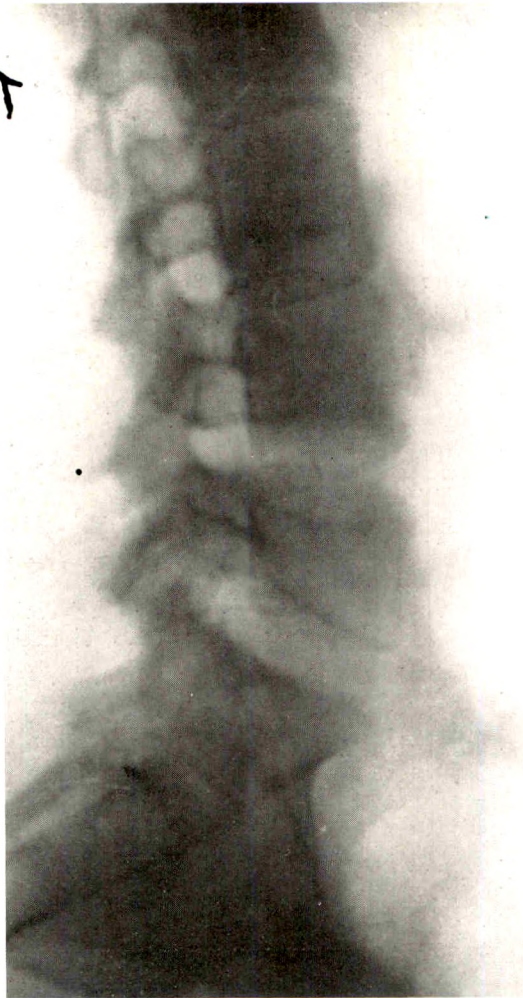


FIG. 1A. Osteomyelitis. Onset of back pain one month after evacuation of furuncle. *Staphylococcus aureus* sepsis. (Operation.) February 16, 1932.

joining halves of protovertebrae and several abnormalities may result at this stage. In this group belong the vertebral fusions, complete, unilateral and cross, due to failure of the halves of the protovertebrae to separate. There may be wedging of one or more vertebrae. Normally a canal remains at the site of the previous interprotovertebral space which serves as a locus minoris resistentiae. That a congenital wedging can occur without the presence of any disease, such as tuberculosis, appears from the case described by Schulthess, in which there was a lumbar kyphosis in a new-born child with a spina bifida,

the deformity having arisen as the result of a fusion of L_3 and L_4 into a wedge-shaped body. Similar studies have been made by Delahaye. Deformity of a supernumerary vertebra is due to the fact that there is no support from an accompanying rib. This causes a lateral backward subluxation and wedging of the offending vertebra. Supernumerary ribs also result in a lateral subluxation and lateral wedging of a vertebra. Often the wedging is not apparent in the lateral film alone. The Klippel-Feil syndrome is associated with the absence of one or more cervical vertebrae, sometimes with wedging of one of the remaining vertebrae and marked deformity. These cases have been reported in great detail in the German literature.

Developmental Disorders. The anatomical studies of Schmorl and their interpretation roentgenographically by Calvé and Galland have established the importance of the nucleus pulposus in a rational understanding of those deformities appearing during development. Occasionally it has been noted that there is a posterior displacement of the nucleus; the fulcrum upon which the vertebrae hinge is therefore more posterior than usual and as a result the anterior intervertebral spaces are narrowed and there is wedging of the corresponding vertebrae. This type of kyphosis is diagnosed by the number of vertebrae involved, the rather uniform degree of wedging and by the occasional appearance of calcification in the nucleus. Undoubtedly, most of the so-called "postural" changes previously ascribed to rickets result from this cause. At no time is there collapse of the bodies or tendency to fusion in rickets. Herniation of the nucleus into spongiosa does not result in deformity, although the latter may appear with an associated osteoporosis.

Kyphosis dorsalis juvenilis, originally described by Scheuermann, is characterized by the fact that it most frequently appears in the 10th and 11th dorsal vertebrae; there is a more or less wedge-shaped vertebra at the culminating point of the

kyphosis. The epiphyses are often larger anteriorly than posteriorly. Frequently they are slightly retracted, differently shaped and situated so as to be in apposition with the vertebral bodies. The whole process thus gives the impression that the juxta-epiphyseal tissue is compressed or atrophied. There is no further alteration when the epiphyses become united with the vertebral bodies. In several cases the affected vertebrae become foreshortened and triangular in shape and there may be spur-like prominences. The diseases described by Calvé and by Buchman are probably the same in nature, although in the so-called Buchman's disease wedging is not a common feature. Rather there is marked irregularity of the articular surfaces of the vertebrae with deformity of the epiphyses. Some cases such as that of Martin and Roesler show similar marked wedging and are listed under the general title of subchondral necrosis.

Deformity of the vertebral bodies as a characteristic of osteogenesis imperfecta is not a common finding roentgenographically. It has been noted pathologically and then apparently consists of bizarre deformities, easy of diagnosis when the deformities of the remainder of the skeletal system are noted.

The local malacias also described as pre-senile osteoporosis, the deformities of achondrodystrophies and dwarfism, are chiefly due to the fact that the resistance of the bony tissue of a vertebra is less than that of the nucleus pulposus and the intervertebral discs are thus pushed up deep into the vertebrae and the latter appear as the vertebrae of fish (Fischwirbel), that is, they are lenticular or biconcave in shape. For this reason the collapse of the bodies is uniform and there is no narrowing of the intervertebral discs, if anything, a slight widening; there are no hypertrophic changes.

Trauma. Fractures of the vertebral bodies are usually compression fractures except in the cervical region where they may be of the longitudinal fissure or crush-



FIG. 1B. March 18, 1932.

ing type. They may, of course, appear with or without dislocation. The compression is usually most marked anteriorly unless there have been, in addition, fractures of the vertebral appendages. The intervertebral space remains intact. After a varying length of time, hypertrophic spurs form at the margins of the injured body and often also at the anterior articular surface of the adjoining vertebra. In fact, the presence of localized hypertrophic spondylitis, with wedging of a body, and without narrowing of the intervertebral discs, usually indicates the presence of an old compression fracture of this body. In 1891 Kümmell described a condition often due only to a slight trauma which may in-



FIG. 1c. April 15, 1932.

volve the vertebral column indirectly, and in which there are no immediate signs except for a transient period of pain in the back, but, after months of complete well-being, a rarefaction of the vertebrae occurs, probably due to an interference with its circulation leading to a nutrition atrophy. Autopsy early in this condition has shown small hematmata within the vertebral body. It is obvious, therefore, that as in the case of hemangiomata of the spine (loc. cit.) there may never be collapse of the body but that, on the other hand, collapse may occur at any time subsequent to the injury. It follows, too, that in a genuine case of Kümmell's disease there was never any fracture and that roentgenograms following the injury will show no ab-

normality. Further, it is only in the presence of such roentgenographic evidence that subsequent post-traumatic vertebral deformity can be ascribed to Kümmell's disease. The Kümmell-Verneuil syndrome is the presence of collapse subsequent to injury with a general malacia of the spine in addition.

Infections. It is our finding that there is a more or less characteristic appearance of the vertebrae, roentgenographically, when they are affected by the staphylococcus, pneumococcus, meningococcus, *B. typhosus* or *paratyphosus*, "grippe," *B. melitensis*, or *B. proteus*. This typically is a localized, ragged, hypertrophic spondylitis, with uniform narrowing of the adjacent intervertebral space and a slight wedging of the body progressing into real destruction and collapse (particularly when the cervical region is affected), with or without abscess. There is always a thickening of the perivertebral fibrous tissue. The features appear in this approximate chronological order. When the infection is due to a pyogenic organism, there is often destruction of a vertebral appendage. This is, of course, a generalization; the changes do not appear until late in the disease, often not for several months after the appearance of symptoms referable to the spine. It is within the experience of many that a vertebral body grossly invaded, as found at post mortem, had shown no definite changes in the roentgenogram. It is important, however, to know that the changes described above do occur in these infections, and that not all narrowing of the intervertebral disc is due to tuberculosis. It is of equal importance in the differential diagnosis from perinephric abscess. Curiously enough, syphilis characteristically gives a different picture, namely, a uniform narrowing of the vertebral body without any change in the intervertebral space and no bone reaction. The only other infection which gives the latter picture, within our experience and as far as can be gleaned from the literature, is an infection with *Brucella abortus*. In the latter, however, the picture is variable. In Jensen's case, for example, there was uniform nar-

rowing of these vertebrae each definitely resembling that of syphilis, while in the case of Lassen, there was no collapse, but a narrowing of the intervertebral joint and hypertrophic spondylitis. Undoubtedly this disease as it affects the spine deserves further study. Smallpox is mentioned chiefly for its potentialities. A definite collapse due to this cause has not been described.

As regards *tuberculosis*, the roentgenographic appearance is best studied in conjunction with the types of pathological invasion. Following the articles of Doub, and the observations of Sgalitzer, tuberculous involvement of the spine may be said to occur in the following ways:

1. Central involvement of the body with a minimum of symptoms until necrosis causes collapse of the body. There is then involvement of the intervertebral disc and adjacent vertebrae.
2. Epiphyseal type of involvement. There is an early narrowing and disappearance of the disc with coaptation of the vertebrae. Early collapse and kyphosis are not seen. Abscess may be the earliest sign.
3. Anterior or peripheral variety. The involved area is below the anterior longitudinal ligament in the anterior portion of the body. It may, however, secondarily invade the body and become central.
4. The vertebral appendages may be invaded.

It is obvious then that differentiation of the first variety from kyphosis dorsalis juvenilis may be very difficult; that the epiphyseal variety may simulate a pyogenic osteomyelitis; that the anterior variety may only be suspected from the demonstration of an abscess. One point, however, may be of assistance; tuberculosis in the absence of secondary infection usually shows very little new bone formation although even this perhaps occurs more often than is thought. The course of the disease is of the utmost differential importance.

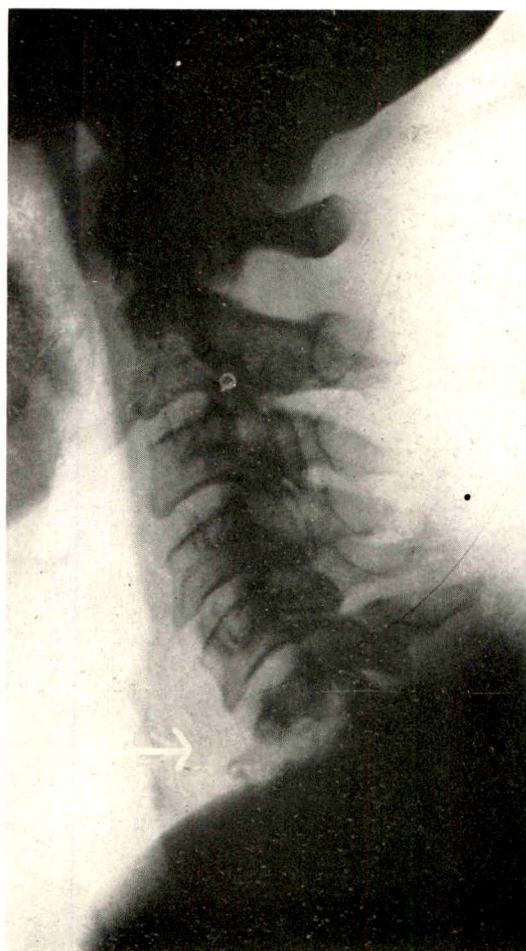


FIG. 2. Syphilis (clinical). Case of cerebrospinal syphilis.

The Charcot spine is characterized by the same appearance as that noted in other joints, the extensive fragmentation of the anterior surface of the bodies. In our experience, this condition will not be confused with any other condition, except perhaps the fungus infections. The latter, however, practically always have an external fistula and roentgenograms are made usually out of curiosity rather than for diagnosis. Echinococcus disease may result in collapse of a vertebra, often with sclerosis about it. Sometimes there is complete destruction. There is no bone reaction nor atrophy. The intervertebral discs are intact. Before collapse, there are round unilateral and unilocular excavations involving one or adjacent vertebrae.

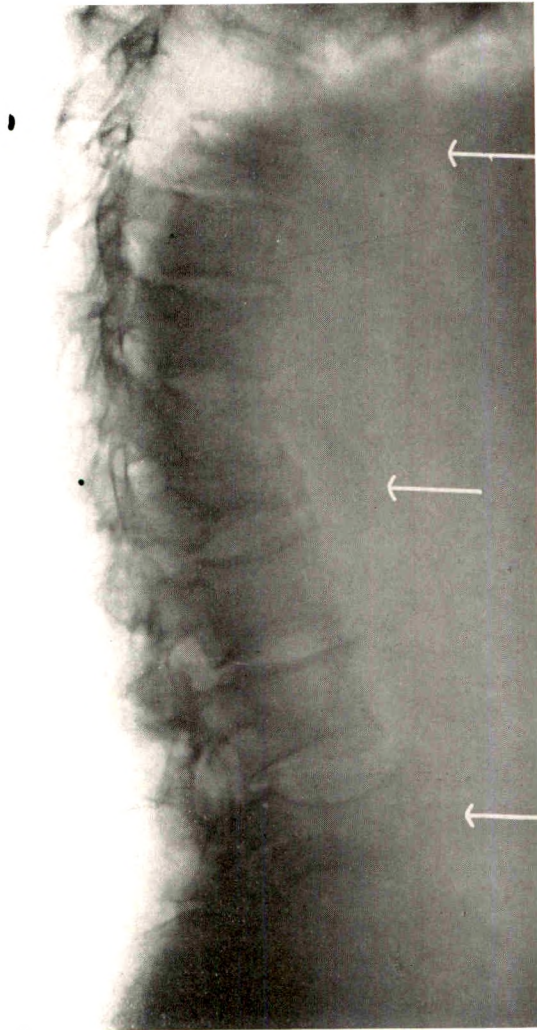


FIG. 3. Amyloidosis (autopsy). Amyloidosis of the liver, bone marrow, adrenals, kidneys and pancreas with collapse of first dorsal and first lumbar vertebrae—etiology not found.

Metabolic Disorders. There are several diseases which may be included in this group which are characterized by practically the same features, namely, a change in the bony structure of the vertebra so that it loses its normal resistance and becomes uniformly compressed by the intact intervertebral disc. The vertebral body assumes the shape of the "Fischwirbel." When the disease is general, all of the spine may be affected, as in osteomalacia. The discs here appear to swell and become spherical. In the hunger osteopathy extensively described

by the Germans, a single vertebra may show this change. Amyloid disease, with invasion of the spine may result in a "Fischwirbel," as in the case of Mandl. There may, however, be uniform collapse without material change in shape except for some wedging. The latter when it occurs is the usual finding in the primary generalized xanthomatoses (Gaucher's disease, Schüller-Christian's syndrome and possibly Niemann-Pick's disease), where the body of the vertebra is completely necrotic and only a thin atrophic cortex and a few spongy trabeculae remain. There may be complete destruction and scar tissue replacement. Kyphosis of this type is often seen with acromegaly in association with pituitary adenoma. Characteristically, then, this group of metabolic diseases is characterized by a narrowing of the vertebral body with either wedging or the assumption of the lenticular shape, and with either no change in the intervertebral space

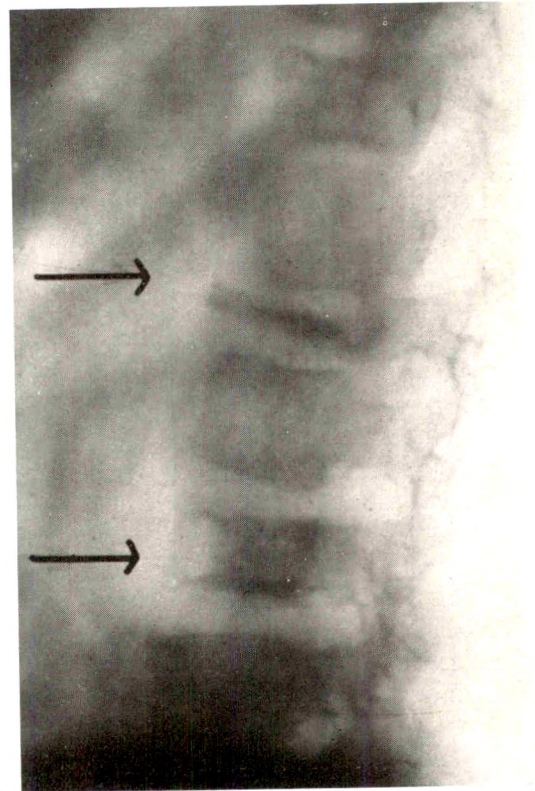


FIG. 4. Gaucher's disease (clinical).

or a relative widening with a spherical appearance. This same appearance is seen in Paget's disease when the rarefying osteitis predominates over the productive process, and particularly when the body is affected to a greater extent than the arches, an anterior bowing results. From the roentgenogram alone, the differentiation of osteitis fibrosa cystica (von Recklinghausen) and osteomalacia often cannot be made. The progressive narrowing of the vertebrae, with the assumption of the "Fischwirbel" shape are characteristic of both. In osteomalacia, the disease is more generalized earlier; in von Recklinghausen's only two or three vertebrae may be involved as

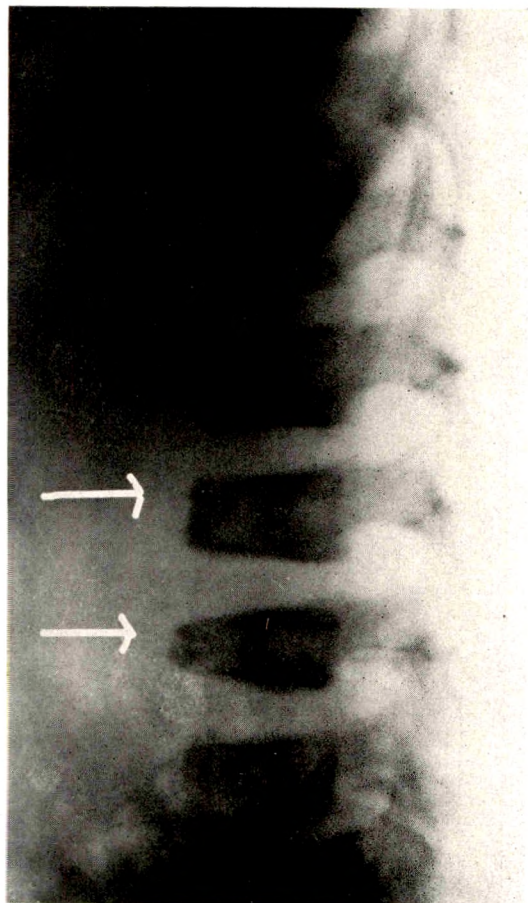


FIG. 5. Myelogenous leukemia (biopsy). Boy aged five with large liver and spleen. Blood count: hemoglobin, 60 per cent; white blood cells, 4,900; polymorphonuclear leucocytes, 1 per cent; myelocytes, 4 per cent; myeloblasts, 80 per cent.

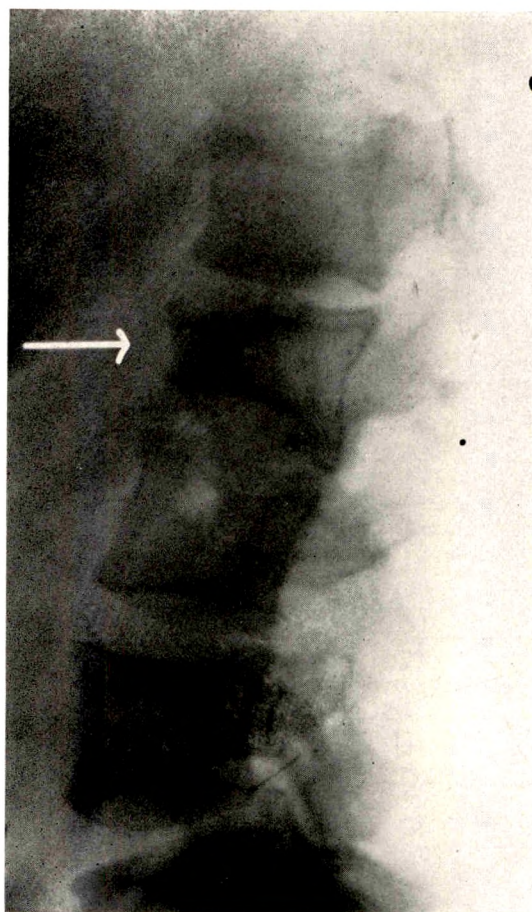


FIG. 6. Hodgkin's disease (biopsy).

far as the roentgenogram is concerned. Examination of the other bones and evidence as to the presence or absence of a parathyroid tumor are of importance.

Blood Dyscrasias. In 1914, Rolleston and Frankau reported a case of acute leukemia simulating caries of the spine. The cancellous tissue of the bodies of the vertebrae was so soft that it could be cut quite easily, and the compact bone was thinned out. There was no collapse of the body. Microscopic examination showed a leucoblastic reaction (lymphocytic-like) but the cells were regarded by the pathologist as myeloblasts or their precursors. The case of Melchior was that of a lymphatic leukemia. Pains in the bones in chronic myelogenous leukemia is a well-known finding, and in Figure 5 is seen a vertebral wedging in a case of chronic

TABLE I
SUMMARY OF DISEASE CHARACTERISTICS
U—Usual; S—Sometimes; O—Not present

Disease	Shape of Vertebral Body						Intervertebral Disc				Gen- eral Atro- phy of Spine	Frag- men- tation	Ap- pend- age Affect- ed	Sub- luxa- tion	Other Mani- festa- tions	Remarks
	Com- plete De- struc- tion	Trian- gular	Wedg- ed	Uni- form Nar- row- ing	"Tisch- wir- bel"	Non- mal Ir- regu- lar	Bone Pro- duc- tion	Nor- mal	Wid- ened	Uni- form Nar- row- ing	Trian- gular	Absent				
<i>Congenital disease</i>																
Klippel-Feil syndrome	Absence		S				O	U					U	O		Other congenital abnormalities
Supernumerary vertebra			U				O	U		S			O	U		
Fusion						U	O					U	O	O		
<i>Developmental</i>																
Retropulsion of nucleus pulposus			U				O				U		O	O	O	
Kyphosis dorsalis juvenilis		S	U				O	U					O	O	O	Köhler's disease, etc. Most of spine
Osteochondritis							O	U					O	O	O	
Presenile osteoporosis			S		U		O	U	S				O	O	O	
Chondrodystrophy			S		U		O	U	S				O	O	S	U
<i>Trauma</i>																
Fracture			U				U	U					O	S	O	Compression only
Kummell's disease			U	S			S	U					O	O	O	
<i>Infections</i>																
Osteomyelitis	S	S	U			S	U			U			O	S	O	
Tuberculosis central	S	U	S				O	U			S	S	O	S		Usual involvement of neighbor
Tuberculosis epiphyseal		S	U			S	O				U	S	O	S		
Syphilis				U			O	U					O	O	O	
Charcot			U				O	U					O	O	S	
Fungus			U			S	U			S			U	U	U	Ext. fistula
Echinococcus	S		U				O	U					O	O	S	
<i>Metabolic</i>																
Hunger				U	S		O	U					O	O	O	General bone affection
Acromegaly				U	U		O	S	U				U	U	U	
Osteitis fibrosa cystica				S	U		O	U	S				O	O	U	
Paget's disease				U	S		U	U					O	O	U	

Metastatic Tumors. The following are characteristics of vertebrae affected by metastatic processes:

The metastases may be of the osteoclastic or osteoblastic variety. In neither case does collapse take place early, even later though, in the osteoblastic type. When collapse does occur, there is a uniform narrowing of the vertebral body; the intervertebral discs remain intact until very late in the disease; there is no bone reaction; there is no kyphosis. Usually, there is seen in the other vertebrae, circular ragged defects in the medulla, spreading to the cortex. In the osteoblastic variety, there is a more or less uniform increase in density of the body without increase in size. When the latter appearance is present, it must be differentiated chiefly from Paget's disease and osteitis condensans. The former differentiation can often be made from the remainder of the skeletal system; the latter is extremely difficult. As far as can be determined from the literature and from our experience, osteitis condensans is not associated with collapse.

Involvement of the spine in Hodgkin's disease, arbitrarily described with tumors, is a common finding, so much so that a constant pain referable to the spine during the course of the disease leads one to believe that metastases are present whether they are demonstrated by the roentgenogram or not. Collapse, however, does occur with frequency and is then indistinguishable from that of carcinoma, in the appearance of the involved body. Usually, however, there are demonstrable metastases in only one or two vertebrae at a time. Lymphosarcoma does not ordinarily involve bone and a case with collapse has not been noted.

The various carcinomatous metastases, from lung, thyroid, breast, gastrointestinal tract, nasopharynx and prostate, as well as those from hypernephroma, neurofibroma and rhabdomyoma, when they cause deformity of the vertebral bodies, cannot be differentiated. Neurofibroma usually results in a marked kyphosis. It is merely a matter of probability that in any given case where the metastases are osteoblastic, in a male, the prostate should be suspected as being the site of the primary lesion,

whereas the presence of collapse with osteoclastic areas suggests the probability of hypernephroma or breast carcinoma.

Pressure Atrophy. Paravertebral pathological conditions do not usually cause collapse of vertebrae. Aneurysms may cause marked pressure atrophy without any definite change in the size or shape of the vertebral bodies or the intervertebral spaces. The outlines are usually well made out but there is a marked decalcification of the body. This is also true in paravertebral sarcomas. After removal of such tumors, there is usually complete regeneration of the vertebral body.

DISCUSSION

It is needless to impress roentgenologists with the necessity for studying the normal appearance of the spine at various ages. Suffice it to make the following criteria:

In the normal vertebra, two systems of bone trabeculae are noted, which intersect perpendicularly and which are interrupted in their continuity by a sagittal canal carrying the main central vein of the body. Each caudally following vertebra is larger than, or at least of the same size as, that of the one above it. A longitudinal diameter of a vertebra shorter than the corresponding diameter of the vertebra above it is to be considered as absolute indication of a pathological involvement of the vertebra. Integrity of the sharpness of the outline and the uniformity of density of a vertebra are of utmost importance. This applies just as well to the intervertebral disc. It is essential to study small sections of the spine at a time, to use cones, compression and proper angulation; the routine use of stereoscopic anteroposterior views as well as the lateral view is advised. In short, complete and technically satisfactory examinations are necessary. The mechanism of the various types of vertebral deformity is to be made the subject of a further communication, where an attempt will be made to offer a rational explanation of why deformity occurs in the way it does in any particular disease. In Table I are summarized the

characteristics of the diseases mentioned in the present article.

CONCLUSIONS

A review of the literature and our own studies indicate that spinal deformity may occur in numerous conditions. In general, it may be said that such a deformity should be studied particularly with regard to the shape of the intervertebral discs, the presence of bone reaction, the presence of

general atrophy of the spine and the manifestations of disease elsewhere. The fact must again be emphasized that diagnosis from a roentgenogram is impossible without, in addition, complete clinical data and correlation.

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REFERENCES

1. ADAMS, F. Syphilis of the cervical vertebrae. *U. S. Vet. Bur. M. Bull.*, 1929, 5, 535-537.
2. ALGAVE. Un cas d'ostéomyélite cervicale primitive chez un adulte de quarante ans. *Bull. et mém. Soc. nat. de chir.*, 1928, 54, 810-812.
3. ARENDT, J. Spondylitis typhosa im Röntgenbild. *Röntgenpraxis*, 1930, 2, 1080-1082.
4. ASKANAZY, M. In: Henke, F., and Lubarsch, Otto, Editors. *Handbuch der speziellen pathologischen Anatomie und Histologie*. Springer, Vienna, 1927.
5. AUCLAIR, WEISSENBACH and AUBOURG. Valeur l'examen radiologique dans le spondylite typhique. *Bull. et mém. Soc. de radiol. méd. de Par.*, 1913, 5, 26-29.
6. BAILEY, P., and BUCY, P. C. Cavernous hemangioma of the vertebrae. *J. Am. M. Ass.*, 1929, 92, 1748-1751.
7. BAUER, W., ALBRIGHT, F., and AUB, J. C. A case of osteitis fibrosa cystica (osteomalacia?) with evidence of hyperactivity of parathyroid bodies. *J. Clin. Investigation*, 1930, 8, 229-248.
8. BENDICK, A. J. Personal communication.
9. BERCHER, L. Spondylite typhique. Thèse. Algiers, 1926.
10. BERKHEISER, E. J. Multiple myelomas of children. *Arch. Surg.*, 1924, 8, 853-881.
11. BILLINGTON, R. W. Spondylitis following cerebrospinal meningitis. *J. Am. M. Ass.*, 1924, 83, 683-686.
12. BORCHARDT, M., and ROTHMANN, M. Zur Kenntnis der Echinokokken der Wirbelsäule und des Rückenmarks. *Arch. f. klin. Chir.*, 1909, 28, 328-378.
13. BORCHERS, G. Ueber die primäre akute und subakute osteomyelitis purulenta der Wirbel. *Arch. f. klin. Chir.*, 1930, 158, 168-190. (Bibliography.)
14. BREWER, G. E., and WOOD, F. C. Blastomycosis of the spine. *Ann. Surg.*, 1908, 48, 889-896.
15. BRICKNER, W. M., and MILCH, H. Pathological fracture of the humerus from carcinomatous metastases from the oesophagus. *Internat. Clin.*, 1926, 1, 207.
16. BRILL, N. E., MANDLEBAUM, F. S., and LIBMAN, E. Primary splenomegaly of the Gaucher type. *Am. J. M. Sc.*, 1909, 127, 849-859.
17. BROCA and NATHAN. *Arch. d. méd. et chir. milit.*, 1919, 72, 282. Quoted by Oudard, Hesnard and Coureaud, ref. 101.
18. BROOKS, B., and LEHMAN, E. P. The bone changes in Recklinghausen's neurofibromatosis. *Surg., Gynec. & Obst.*, 1924, 38, 587-595.
19. BUCHMAN, J. A résumé of the osteochondritides. *Surg., Gynec. & Obst.*, 1929, 49, 447-453.
20. BUCY, P. C., and CAPP, C. S. Primary hemangioma of bone. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1930, 23, 1-33.
21. BUHL. *Ztschr. f. Biol.*, 1865, 1, 163. Quoted by Ewing, ref. 41.
22. BUMPUS, H. C., Jr. Carcinoma of the prostate. *Surg., Gynec. & Obst.*, 1921, 32, 31.
23. CALVÉ, J., and GALLAND, M. The intervertebral nucleus pulposus; its anatomy, its physiology, its pathology. *J. Bone & Joint Surg.*, 1930, 12, 555-578.
24. CALVÉ, J. A localized affection of the spine suggesting osteochondritis of the vertebral body, with clinical aspect of Pott's disease. *J. Bone & Joint Surg.*, 1925, 7, 41-46.
25. CANTALOUBE. Quoted by Roger, H. La spondylite méliococcique. *Presse méd.*, 1926, 34, 929-930.
26. CARAVEN, J. Osteitis et osteo-arthritis mycosiques. *J. de chir.*, 1910, 4, 368-387.
27. CARSON, H. W. Acute osteomyelitis of the spine. *Brit. J. Surg.*, 1930-1931, 18, 400-408.
28. CATHCART, J. W. Bone dystrophies of variola. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1924, 11, 229-231.
29. COFIELD, R. B., and LITTLE, C. F. Syphilitic spondylitis. *J. Am. M. Ass.*, 1925, 84, 174-177.
30. COTTON, A. Giant cell tumor of the spine. *Am.*

- J. ROENTGENOL. & RAD. THERAPY, 1928, 20, 18-24.
31. CUSHWAY, B. C., and MAIER, R. J. Radiological studies of the anatomical variations observed in symptomless spine. *Illinois M. J.*, 1929, 55, 355-356.
32. DELAHAYE, A. Quelques détails de l'ossification vertébrale précises par la radiographie. *J. de radiol. et d'électrol.*, 1924, 8, 167-170.
33. DOUB, H. P., and BADGLEY, C. E. Tuberculosis of the intervertebral articulations. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1931, 25, 299-307.
34. DOUB, H. P., and BADGLEY, C. E. The roentgen signs of tuberculosis of the vertebral body. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1932, 27, 827-837.
35. DRESSER, R. Metastatic manifestations of hypernephroma in bone. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1925, 13, 342-353.
36. DURMAN, D. C. Myeloma of the spine. *Ann. Surg.*, 1928, 88, 975-984.
37. EDENS. Ueber lokale und allgemeines Amyloid. *Virchow's Arch. f. path. Anat. (etc.)*, 1906, 184, 137-149.
38. EHRRARDT, O. Zur Anatomie und Klinik der Struma maligna. *Beitr. z. klin. Chir.*, 1902, 35, 343-464.
39. EUZIÈRE, LAMARQUE, P., and others. Un cas de maladie de Recklinghausen avec cyphoscoliose et paraplégie. *Arch. Soc. de sc. méd. et biol. de Montpellier*, 1929, 10, 340-348.
40. EVANS, W. A. Abnormalities of the vertebral body. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1932, 27, 801-817.
41. EWING, J. Neoplastic Diseases. W. B. Saunders Co., Philadelphia, 1928.
42. GEORGE, A. W., and LEONARD, R. D. The Vertebrae Roentgenologically Considered. *Ann. Roentgenol.*, Vol. 8. Paul B. Hoeber, Inc., New York, 1929.
43. GESCHICKTER, C. F., and COPELAND, M. M. Tumors of Bone. American Journal of Cancer, New York, 1931.
44. GESCHICKTER, C. F., and COPELAND, M. M. Multiple myeloma. *Arch. Surg.*, 1928, 16, 807-863.
45. GIBBONS, H. W. The relation of Hodgkin's disease to lymphosarcoma. *Am. J. M. Sc.*, 1906, 132, 692-704.
46. GIBSON, A., and BLOODGOOD, J. C. Metastatic hypernephroma with special reference to bone metastasis. *Surg., Gynec. & Obst.*, 1923, 37, 490-505.
47. GOLD, E. Von den Wirbelveränderungen im Falle eines Hämangioms an der Dura spinalis. *Arch. f. klin. Chir.*, 1926, 139, 729-761.
48. GROVE, J. S., and KRAMER, S. E. Primary carcinoma of the lung. *Am. J. M. Sc.*, 1926, 171, 250-282.
49. GUILLAIN, G., DECOURT, J., and BERTRAND, I. Compression médullaire par angioma vertébral. *Ann. de méd.*, 1928, 23, 5-21.
50. GUILLEMIN, A., and MATHIEU, L. Spondylite typhique. *Bull. et mém. Soc. nat. de chir.*, 1929, 55, 1411-1417.
51. HANSON, R. Some anomalies, deformities and diseased conditions of the vertebrae during their different stages of development, elucidated by anatomical and radiological findings. *Acta chir. Scandinav.*, 1926, 60, 309-368.
52. HARRENSTEIN, R. J. Ueber einige, von diagnostischen Gesichtspunkt aus irreführende Variationen in der Entwicklung der Wirbelsäule. *Ztschr. f. orthop. Chir.*, 1928, 49, 568-581.
53. HARRINGTON, A. W., and KENNEDY, A. M. Bone-marrow metastases and anaemia in gastric ulcer. *Lancet*, 1913, 1, 378-380.
54. HENRY, M. O. Acute osteomyelitis of the spine. *J. Bone & Joint Surg.*, 1929, 11, 536-539.
55. HINES, L. E. Compression myelitis secondary to echinococcus disease of the vertebrae and kidney. *Arch. Path. & Lab. Med.*, 1926, 1, 180-181.
56. HIRSCH, E. F., and RYERSON, E. W. Metastases of bone in primary carcinoma of the lung. *Arch. Surg.*, 1928, 16, 1-30.
57. HORN. Beitrag zur Diagnose der Spondylitis luetica. *Röntgenpraxis*, 1932, 4, 31-36.
58. VON HOLST, L. Die Spondylitis nach Fleck- und Rückfallfieber im Röntgenbilde. *Ztschr. f. orthop. Chir.*, 1924-1925, 46, 321-372.
59. HOWLAND, J., and RICH, A. Gaucher's disease with extensive involvement of the bones and invasion of the spinal canal. *Tr. Am. Pediat. Soc.*, 1924, 36, 42.
60. HUTTON, A. J., and YOUNG, A. Chordoma. *Surg., Gynec. & Obst.*, 1929, 48, 333-344.
61. JENKINSON, E. L. Primary carcinoma of the gastrointestinal tract accompanied by bone metastasis. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1924, 11, 411-420.
62. JENSEN, J. P. Spondylitis due to Bacillus abortus Bang. *Hospitaltid.*, 1928, 71, 637-646.
63. JOLL, C. A. Metastatic tumours of bones. *Brit. J. Surg.*, 1923-1924, 11, 38-72.
64. JUNGHANNS, H. Die Zwischenwirbelscheiben im Röntgenbild. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1931, 43, 275-305.
65. KARSHNER, R. G. Roentgen studies of the bones in certain diseases of the blood and hematopoietic system. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1928, 20, 433-439.
66. KAUFMANN, E. Pathology for Students and Practitioners. Translated by S. P. Reimann.

- P. Blakiston's Son & Co., Philadelphia, 1929.
57. KESMODEL, K. F. Primary sarcoma of vertebrae. *AM. J. ROENTGENOL.*, 1921, 8, 573-577.
 58. KIENBÖCK, R. Die Krankheiten der Wirbelsäule im Röntgenbild. *Wien. klin. Wchnschr.*, 1931, 44, 232-234.
 59. KOLODNY, A. Bone Sarcoma. Surgical Publishing Co., Chicago, 1927.
 60. KREMSEK, C. Ueber Veränderungen an Knochen bei der Hodgkinschen Krankheit. *Röntgenpraxis*, 1930, 2, 998-1002.
 71. KREUZER, H. Ueber Osteomalazie der Wirbelsäule. *Ztschr. f. orthop. Chir.*, 1929, 51, 463-471.
 72. KRUMBHAAR, E. B. Hodgkin's disease of bone marrow and spleen without apparent involvement of lymph nodes. *Am. J. M. Sc.*, 1931, 182, 764-769.
 73. KÜMMELL, H. Die rarefizierende Ostitis der Wirbelkörper. *Verhandl. d. Gesellsch. deutsch. Naturf. u. Aerzte*, 1891, 282.
 74. KÜMMELL, H. Ueber die traumatischen Erkrankungen der Wirbelsäule. *Deutsche med. Wchnschr.*, 1895, 21, 180-181.
 75. KÜMMELL, H. Die posttraumatische Wirbelerkrankung (Kümmellsche Krankheit). *Arch. f. klin. Chir.*, 1921, 118, 876-901.
 76. LAMY and LÉPENNÉTIER. Malformation vertébrale post-traumatique d'aspect ostéomalacique. *Bull. et mém. Soc. de radiol. méd. de France*, 1929, 17, 268.
 77. LANCE, M. Syndrome de Kümmell-Verneuil. Fracture et ostéomalacie étendue du rachis. *Bull. et mém. Soc. nat. de chir.*, 1930, 56, 574-583.
 78. LASSEN, H. K. Et tilfaelde af spondylitis paa basis af infektion med. Bac. abortus (Bang). *Hospitalstid.*, 1930, 73, 64-71.
 79. LE GENISSEL and GOINARD, P. Diagnostic radiologique de l'échinococcose rachidienne. *J. de radiol. et d'électrol.*, 1931, 15, 203-205.
 80. LEIBOVICI, R. L'ostéomyélite vertébrale. *J. de chir.*, 1928, 32, 648-671.
 81. LEWIS, DEAN. Primary giant cell tumors of the vertebrae. *J. Am. M. Ass.*, 1924, 83, 1224-1229.
 82. LEXER, E., KULIGA, P., et al. Untersuchungen über Knochenarterien mittelst Röntgenaufnahmen injizierter Knochen und ihre Bedeutung für einzelne pathologische Vorgänge am Knochensysteme. A. Hirschwald, Berlin, 1904.
 83. LOEWENBERG, R. D., and WEHMER, M. Ueber Wirbelarthropathie und Amyotrophie bei Tabes dorsalis. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1929, 40, 492-496.
 84. LYON, E. Die Wirbelsäulengicht. *Arch. f. Verdauungskr.*, 1929, 46, 88-96.
 85. MANDL, J. Ueber lokales Amyloid im Bereiche der Brustwirbelsäule. *Virchow's Arch. f. path. Anat.*, 1924, 253, 639-655.
 86. MARTIN, W. C., and ROESLER, H. Multiple manifestations of subchondral necrosis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1931, 26, 861-867.
 87. MARTLAND, H. S. The occurrence of malignancy in radioactive persons. *Am. J. Cancer*, 1931, 15, 2435-2516.
 88. MATHIEU. *Rev. de chir.*, 1924, 62, 96.
 89. MCCREA, T. Typhoid and paratyphoid spondylitis with bony changes in the vertebrae. *Am. J. M. Sc.*, 1906, 132, 878-889.
 90. MELCHIOR, E. Spondylopathia leucaemica. *Zentralbl. f. Chir.*, 1922, 49, 1737-1740.
 91. MICHAELIS, L. Ueber Wirbelsäulenveränderungen bei Neurofibromatose. *Beitr. z. klin. Chir.*, 1930, 150, 574-587.
 92. MILCH, H., and LAPIDUS, P. W. Pneumococcus spondylitis. *J. Bone & Joint Surg.*, 1929, 11, 292-297.
 93. MOORE, A. B. A roentgenologic study of metastatic malignancy of the bones. *AM. J. ROENTGENOL.*, 1919, 6, 589-593.
 94. MOON, V. H. Primary carcinoma of the liver with metastasis to bone. *Arch. Path.*, 1929, 8, 938-943.
 95. MONTGOMERY, A. H. Hodgkin's disease of bones. *Ann. Surg.*, 1928, 87, 755-766.
 96. MOURE, P. La sporotrichose au point de vue chirurgical. *Rev. de chir.*, 1919, 57, 366-494.
 97. MÜLLER, W. Ueber Wirbelveränderungen bei Störungen der Hypophysenfunktion. *Beitr. z. klin. Chir.*, 1930, 148, 493-509.
 98. MURPHY, J. B. Bone and joint disease in relation to typhoid fever. *Surg., Gynec. & Obst.*, 1916, 23, 119-143.
 99. NAEGELI, TH. Skoliosen infolge angeborener Anomalie der Wirbelsäule. *Beitr. z. klin. Chir.*, 1916, 99, 128-137.
 100. NATHAN, W. Hypernephrommetastase unter dem Bilde eines Elfenbeinwirbels. *Röntgenpraxis*, 1931, 3, 994-997.
 101. OUDARD, P., HESNARD, A., and COUREAUD, H. Le diagnostic dans les affections de la colonne vertébrale. Masson et Cie, Paris, 1928.
 102. OSGOOD, R. B. Myeloma of vertebrae. *Boston M. & S. J.*, 1923, 188, 380-387.
 103. PAPE, R. Ueber die Differentialdiagnose tabischer Wirbelveränderungen. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1929, 39, 1066-1078.
 104. PARKER, C. A. Actinomycosis and blastomycosis of the spine. *J. Bone & Joint Surg.*, 1923, 5, 759-777.
 105. PATTON, C. L. Acute osteomyelitis of the spine. *Illinois M. J.*, 1930, 57, 268-272.
 106. PEROTTI, D. Contributo allo studio del significato di alcune particolari alterazioni dei corpi vertebrali. *Radiol. med.*, 1930, 17, 932-940.

107. PICK, L. Zur pathologischen Anatomie des Morbus Gaucher. *Med. Klin.*, 1922, 18, 1408.
108. PICK, L. Die Skelettforn (ossuäre Forn) des Morbus Gaucher. Gustav Fischer, Jena, 1927.
109. PICK, L. Clinical aspects and pathological anatomy of diseases of lipoid metabolism. Janeway Lectures. Mt. Sinai Hospital, New York City, April, 1932.
110. POLGAR, F. Ueber Plattwirbel (Platyspondylie; präsenile Osteoporese). *Röntgenpraxis*, 1931, 3, 346-357.
111. PONCET and BORCHARD. L'acténotomycose. 1898.
112. PUTTI, V. Malignant bone tumors. *Surg. Gynec. & Obst.*, 1929, 48, 324-332.
113. PYTEL, A., and SCHAJEWITSCH, S. S. Beitrag zur Frage der Klippel-Feilschen Krankheit. *Röntgenpraxis*, 1929, 1, 864-872.
114. RADT, P. Ueber chronische Osteomyelitis der Wirbelsäule und des Kreuzbeins. *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1929, 41, 339-401.
115. ROBIN, N. H. An unusual metastatic manifestation of Hodgkin's granuloma. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1925, 14, 251-252.
116. ROGER, H. *Soc. de méd. colon. de Marseille*, April 9, 1925.
117. ROHRHIRSCH, O. Primäres Sarkom der Wirbelsäule. *Röntgenpraxis*, 1931, 3, 208-211.
118. ROLLESTON, H. D., and FRANKAU, C. S. Acute leucemia simulating caries of the spine. *Lancet*, 1914, 1, 173.
119. RUGGLES, H. E. Dwarfism due to disordered epiphyseal development. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1931, 25, 91-94.
120. SANTOS, J. V. Giant cell tumor of the spine. *Ann. Surg.*, 1930, 91, 37-43.
121. SCHANZ, A. Warum entsteht bei Druckwund der Wirbelsäule durch Aortenaneurysm kein Gibbus? *Arch. f. Orthop.*, 1930, 28, 528-531.
122. SCHEUERMANN, H. Cyphose juvenile. *Arch. méd. belges*, 1928, 81, 353-364.
123. SCHMID, H. Ueber lokale Amyloidose in Bereiche des Oberkiefers und der Wirbelsäule. *Punang. Diss.* Zurich, 1919.
124. SCHMIDT, F. Ein Beitrag zur Osteodystrophia generalisata (v. Recklinghausen). *Röntgenpraxis*, 1932, 4, 59-67.
125. SCHMORI, G. Die pathologische Anatomie der Wirbelsäule. *Verhandl. d. deutsch. orthop. Gesellsch.*, 1926, 21, 3.
126. SERIO, F. Sulle spondiliti melitococciche. *Arch. di pat. et clin. med.*, 1927, 6, 247-257.
127. SGALITZER, M. Röntgenologische Studien zum Nachweis der Wirbeltuberculose in einem frühen Stadium. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1929, 40, 761-786.
128. SICARD, BELOT, COSTE and GASTAUD. Aspects radiographique du cancer vertébrale. *J. de radiol. et d'électrol.*, 1925, 9, 353-382.
129. SILHOL. L'acténotomycose. *Bull. Acad. de méd.*, July 5, 1921.
130. SILFVERSKIÖLD, NILS. A "forme fruste" of chondrodystrophia with changes simulating several of the known "local malacias." *Acta radiol.*, 1925, 4, 44-57.
131. SIMPSON, W. M. Thyroid metastasis to bones. *Surg., Gynec. & Obst.*, 1926, 42, 489-507.
132. SIMPSON, W. M. Diffuse vertebral metastasis of prostatic carcinoma without bony changes. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1926, 15, 534-541.
133. SHARP, E. A., and JACOBS, W. F. Chondromyxosarcoma of the sixth cervical vertebra. *Arch. Neurol. & Psychiat.*, 1929, 21, 381-385.
134. SPILLER, U. Multiples Myelom, Spondylarthritits deformans und senile Osteoporose an der Wirbelsäule. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1930, 42, 191-205.
135. STEINDLER, A. Osteomyelitis of the spine. *J. Iowa Med. Soc.*, 1930, 20, 246-249.
136. STEINDLER, A. Diseases and Deformities of the Spine and Thorax. C. V. Mosby Co., St. Louis, 1929.
137. SUTHERLAND, C. G. Roentgenographic study of the developmental anomalies of the spine. *J. Radiol.*, 1922, 3, 357-364.
138. UBERALL, H. Ueber lokalisierte Ostitis fibrosa der Wirbelsäule. *Deutsche Ztschr. f. Chir.*, 1929, 215, 108-114.
139. VALENTIN, B. Knochensystemerkrankung (atypische Chondrodystrophie, Osteochondropathia multiplex) und sogenannte Platyspondylia generalisata. *Zentralbl. f. Chir.*, 1930, 57, 2038-2050.
140. VALLEBONA, A. Sulle alterazioni delle ossa nella tabe dorsale. Artropatie e spondyliti tabetiche. *Radiol. med.*, 1929, 16, 500-527.
141. WAGONER, G., and PENDERGRASS, E. P. Intrinsic circulation of the vertebral body. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 27, 818-826.
142. WEISS, FLORENTIN, Tumor der Rachenhinterwand, wahrscheinlich Spondylitis. *Wien. med. Wchnschr.*, 1928, 78, 588.
143. WELT, S., ROSENTHAL, N., and OPPENHEIMER, B. S. Gaucher's splenomegaly, with especial reference to skeletal changes. *J. Am. M. Ass.*, 1929, 92, 637-644.
144. WILCOX, H. W. Primary malignant disease of the spinal column. *Colorado Med.*, 1930, 27, 200-201.
145. WILENSKY, A. O. Osteomyelitis of the Vertebrae. *Ann. Surg.*, 1929, 89, 561.
146. WILLIS, R. A. Hydatid disease of the spine. *M. J. Australia*, 1928, 2, 306.
147. WILLIS, T. A. Analysis of vertebral anomalies. *Am. J. Surg.*, 1929, 6, 163-168.
148. WULFSOHN, N. Ostitis und Periostitis gummosa der Halswirbelsäule. *Deutsche med. Wchnschr.*, 1929, 55, 186.
149. ZATKIN, S. Zur Frage über die Scheuermannsche Krankheit. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1929, 39, 657-658.

CALCAREOUS CONCRETIONS IN RAYNAUD'S DISEASE

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MULTIPLE subcutaneous calcareous deposits ("interstitial calcinosis") have been described as being associated with a number of diseases. Particularly in connection with scleroderma and sclerodactylia, these deposits have been reported with increasing frequency in recent years. Such an association with Raynaud's disease has been less frequently observed.

Apparently the earliest report was by Lewandowsky⁶ in 1905. A farmer's wife, aged fifty-seven, had had asphyxial paroxysms in the fingers of both hands for five years, nodules in the right forearm and around the right elbow for two years, and thickened, immobile skin over the fingers, with limitation of joint motion, for an unstated period. Although Lewandowsky speculates at some length on the cause of the phenomenon, he makes no mention of either Raynaud's disease or sclerodactylia.

In 1911 Davis¹ reported the case of a white woman, aged thirty-four, who had had Raynaud's disease for "many years," sclerodactylia and calcareous nodules for the past eight years. The deposits were found in the fingers of both hands and around one elbow.

Hunter's⁴ patient, a white housewife, aged thirty-eight, had had Raynaud's disease since the age of fourteen, scleroderma involving hands, forearms, face, neck, back, and buttocks since the age of eighteen, calcinosis since the age of twenty-one. Concretions were present around interphalangeal and metacarpophalangeal joints, as well as in the region of the left olecranon.

Weissenbach et al⁸ report the case of a woman who had had Raynaud's disease for fifteen years and sclerodactylia for three years; for five or six years she had had nodules over her knees, discharging through ulcerations soon after they developed. Chemical analysis of these nodules showed them to be composed chiefly (80.8 per cent) of organic matter, and roentgen studies were entirely negative.

Garcin et al³ report the case of a married woman, aged sixty-five, who had had typical attacks of local syncope since the age of eighteen,

but no asphyxial stage until the menopause, and no history of scleroderma or sclerodactylia except during the past nine years. During the past five years she had discharged concretions from the fingers of both hands. Nodules were excised for histological and chemical examination. All were in the subcutaneous layer of connective tissue; none represented thrombosis or atheromatous change of arteries or veins. Some gave the histological appearance of hyalin; chemical analysis showed them to be composed chiefly of organic matter. Others appeared to be calcified, and chemical analysis yielded chiefly calcium carbonate and phosphates. On the basis of these data Garcin and his co-workers offered the hypothesis that areas of ischemic necrosis results from the paroxysms of vasoconstriction, the necrotic areas becoming hyalinized and later calcified.

It will be noted that in all of the above cases the presence of scleroderma complicated the picture. In one instance the nodules preceded sclerodactylia, in one they appeared concomitantly, and in two they followed scleroderma. In the remaining case the duration of sclerodactylia is not stated. Three cases are cited below in which no scleroderma is described.

Logan⁷ demonstrated by roentgenograms nodules in all the fingers of both hands in a woman, aged twenty-five, who had had chilblains of hands and feet as long as she could remember.

Lehrnbecher's⁵ patient developed Raynaud's disease in the fingers at the age of eighteen, in the toes at the age of twenty-nine, and nodules in the fingers of both hands and near the left olecranon at thirty-five. These concretions were extruded through ulcerations, and after several months very few were seen in roentgen studies; during this time the patient had shown marked clinical improvement under treatment.

Weissenbach et al⁹ report the case of a woman, aged forty-one, who first developed Raynaud's disease at the age of fifteen, and had had digital concretions since the age of twenty. In addition to these, roentgen exami-

nation also showed slight atrophy of some of the terminal phalanges, a finding not uncommon in Raynaud's disease. Chemical analysis of the nodules yielded about 75 per cent calcium carbonate and phosphates.

The following case is added to the group presenting the typical Raynaud picture,



FIG. 1.

with calcareous concretions but without scleroderma or sclerodactylia:

C.E.G., a white, Gentile, rural housewife, aged fifty-six, entered the hospital May 26, 1932, with a complaint of aching of the fingers of over thirty years' duration and repeated ulceration of four years' duration.

Family and past history were irrelevant. The patient denied use of alcohol, tobacco, or drugs. She had never been pregnant, although married twenty-five years.

Twenty-two years ago the patient's finger first became white when exposed to cold. This started in the left ring finger, gradually involving other fingers until within ten years all were affected. Meanwhile a similar but less marked disturbance was appearing in the toes. Normal color could always be restored by dipping the affected parts alternately in hot and cold water.

After several years the local syncope was followed by a period of asphyxia, and for the past five years this has come on directly without any preliminary syncope. During the past four years painful, tender, burning ulcers have

appeared on all the fingers of both hands, crusting and discharging thick, stringy pus and sometimes small, stony bodies. All the ulcerations have healed with cicatrization, but secondary ulcers have appeared on several fingers. There have been marked blueness, swelling, and pain in all the fingers, redness of the hands, edema extending to the elbows, and aching pains radiating to the shoulders. In the legs there have been blueness and pitting edema to the knees, and painful, cold, blue toes without ulceration.

Physical examination revealed a fairly well developed and nourished white woman with an abnormally dry skin. Blood pressure was 140/80. Head, ears, eyes, nose, mouth, teeth, throat, chest, lungs, abdomen, pelvis, spine and reflexes were essentially negative. The heart was of normal size, rate 90-100, rhythm regular. A soft systolic murmur was heard at the apex.

All toes were cold and of a deep blue color; the legs were mottled blue up to the knees, with moderate pitting edema around the ankles. All the fingers were blue and swollen; the skin was dry, horny, slightly thickened, but freely movable on the subcutaneous tissue, which was not hard. There was no limitation of or pain on flexion or extension at any joint. All the fingers showed scars of old ulcerations; yellow crusts were seen and hard nodules could be felt in the left index finger and the right thumb, middle and little fingers.

Routine blood and urine studies were negative, as were the Wassermann and Hinton reactions. Basal metabolism was -18 at the only determination done.

Skin temperatures in all four extremities showed a satisfactory response to novocaine injection of peripheral nerves and the appropriate ganglia. Bilateral lumbar sympathetic neurectomy gave complete symptomatic relief in the lower extremities and restored normal color and temperature.

Roentgen Examination. Films of the left hand obtained shortly after admission showed conical atrophic terminal phalanges, with multiple areas of increased density in the subcutaneous tissue around these phalanges. In the right hand there was no definite atrophy of the phalangeal tips, but there were multiple areas of increased density in the subcutaneous tissue on the flexor surface of the terminal phalanges of the thumb, middle finger, and little finger (Fig. 1). Films of the feet showed some atrophy of the

terminal phalanges but no areas suggesting calcareous concretions. Over the left tibia were several small round areas of slightly increased density, interpreted as phleboliths. Roentgen study was otherwise negative.

COMMENT

From a roentgenologic standpoint, the following features are of some interest:

1. The fact that these concretions show varying degrees of density, some of them not even being opaque to the roentgen rays, is a point in favor of Garcin's suggestion that the nodules are islands of necrosis, resulting from ischemia, which become hyalinized and later calcified.³
2. The predominance of the calcareous deposits in the fingers, particularly in those fingers most severely afflicted with paroxysms of syncope and asphyxia, as noted by several observers, also favors Garcin's hypothesis. On the other hand, it is difficult to reconcile his explanation with the occasional occurrence of nodules around knees and elbows when these areas are not clinically involved. Moreover, one would expect concretions to be found in the toes; such a finding has not yet been reported.
3. The size of the deposits argues against

the possibility that they are areas of calcification in the small arteries and veins of the fingers.

4. Roentgenographic demonstration of multiple dense areas in the subcutaneous tissue is a striking but not an early finding, and hence of no great value in diagnosis. Clinical symptoms and signs are present years before.

5. Finally, the conclusion of Edeiken² that "sclerodactylia is the only condition which will give the roentgenologic picture of calcareous deposits in the finger-tips combined with bone absorption of the tips of the phalanges" seems unwarranted. The same roentgenologic picture may be present in Raynaud's disease.

SUMMARY

Multiple subcutaneous nodules are occasionally found in Raynaud's disease with or without scleroderma; when present they frequently contain a large percentage of calcium salts and are demonstrable roentgenographically. Such deposits have been described in the fingers, around the elbows, and around the knees. Eight cases from the literature are briefly reviewed and a new case added.

REFERENCES

1. DAVIS, H. Case of Raynaud's disease associated with calcareous degeneration. *Brit. J. Dermat.*, 1912, 24, 142-144.
2. EDEIKEN, L. Scleroderma with sclerodactylia. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1929, 22, 42-44.
3. GARCIN, R., BERTRAND, I., LAUDAT, M., and CACHIN, C. Concrétions calcaires sous-cutanées des doigts, associées à un syndrome de Raynaud avec sclérodactylia. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1931, 47, 1036-1045.
4. HUNTER, W. K. Scleroderma with subcutaneous calcareous deposits. *Glasgow Med. J.*, 1913, 79, 241-250.
5. LEHRNBECHER, A. Ueber Calcinosis interstitialis und ihre Beziehungen zur Raynaud'schen Krankheit. *Beitr. z. klin. Chir.*, 1928, 142, 380-397.
6. LEWANDOWSKY, F. Ueber subkutane und periartikuläre Verkalkungen. *Virchow's Arch. f. path. Anat.*, 1905, 181, 179-199.
7. LOGAN, J. R. Unusual calcareous deposits in the soft tissues of the hand. *Arch. Radiol. & Electroth.*, 1923, 28, 55-56.
8. WEISSENBAACH, R. J., TRUCHOT, P., LAUDAT, M., and BASCH, G. Un cas de concrétions calcaires de la sclérodémie. *Bull. Soc. franc. de dermat. et syph.*, 1931, 38, 801-807.
9. WEISSENBAACH, R. J., VIGNAL, E. W., and GUILLEMIN, C. O. Concrétions calcaires sous-cutanées des doigts, associées à une acrocyanose permanente avec accès d'acrocyanose paroxystique (syndrome Raynaud). *Bull. Soc. franc. de dermat. et syph.*, 1929, 36, 910.



THE GENEALOGY OF THE ROENTGEN RAYS

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"In the history of Science, nothing is more true than that the discoverer, even the greatest discoverer, is but the descendant of his scientific fore-fathers; he is always essentially the product of the age in which he is born."

(Sylvanus P. Thompson, *The Roentgen Society*, London, Nov. 5, 1897).

LATE in October of 1895, Professor W. C. Roentgen, who was at that time the director of the Physical Institute of the Würzburg University, decided to experiment with cathode rays. The brilliant research work of Hertz, Lenard, and others, had revealed many new and interesting phenomena which suggested to him the probability that there were still many unsolved problems in connection with these experiments.

Roentgen set up his apparatus in one of the smaller laboratories of the Physical Institute of the University. This apparatus was similar to that then in use in many physical laboratories and lecture rooms all over the world. It consisted of a Ruhmkorff induction coil with a mercury interrupter and a Hittorf-Crookes tube. This simple apparatus was based on principles developed during three centuries through the labor of many students and ingenious investigators, including such men as Gilbert, Torricelli, von Guericke, Boyle, Hauksbee, Abbé Nollet, Franklin, Galvani, Volta, Oerstedt, Ampère, Ohm, Faraday, Henry, Plücker, Hittorf, Crookes, Hertz, Goldstein, Lenard, and many others. It was a simple apparatus, and yet it was destined to become the tool used to discover a phenomenon which will stand forever as the cornerstone of the proud structure of roentgenology which has since been erected by the natural and medical sciences.

In order to evaluate properly Roentgen's discovery of x-rays it is necessary to review

the work of his "scientific fore-fathers," as they are called by Sylvanus P. Thompson, the English physicist and an enthusiastic admirer of Roentgen. In tracing these scientific forefathers, it is necessary to go back in ancient history to Thales of Milet, and to Theophrast. The former in 600 B.C. and the latter in 321 B.C. independently observed that friction caused amber to attract light bodies and therefore discovered the first "electric" phenomenon. These observations were entirely forgotten but they were re-discovered in the Middle Ages and this re-discovery was the real birth of present-day knowledge of electricity and of magnetism.

One of the first and fundamental contributions to the study of electricity was made by William Gilbert (1540-1603) (Fig. 1) who was born in Colchester, Essex County, England, on May 24, 1540, the brilliant son of Jerome Gilbert, a recorder of archives. He studied in St. John's College at Cambridge University and in 1569 he took the degrees of A.B., M.A., and M.D. He then became a Senior Fellow of St. John's College and afterwards a well-known physician; he was appointed Royal Physician to Queen Elizabeth of England. In 1600, at the age of sixty, he was elected president of the Royal College of Physicians after he had held several offices in that society. In addition to his numerous professional duties, Gilbert devoted many hours to research work and after eighteen years of hard work, he published his famous work under the title "De Magnete, Magneticisque Corporibus, et de Magno Magnete Tellure; Physiologia Nova, Plurimis & Argumentis, & Experimentis Demonstrata. Londini, Excudebat Petrus Short, Anno 1600" (Of the magnet, magnetic bodies, and of that great magnet, the earth, the new physiology, set forth by many

arguments and experiments) (Title page, Fig. 2) in London, and later in many other cities (Stettin 1628, Editio Secunda, 1633; Frankfurt 1629, 1638). He dedicated this book to those "... who not only in books but in things themselves look for knowledge." This treatise was recognized throughout the civilized world as authoritative information on magnetism and "electrical" observations and formed the real scientific foundation of subsequent investigations of electricity and magnetism. Gilbert was one of the first scientists to become dissatisfied with the lack of logic and system in the "experiments" of the alchemists, and emphasized the importance of accurate and detailed observations and information. He said once, "There are many books about hidden, abstruse and occult causes and wonders . . . words alone, without experimental proof. All of my own experiments were repeated again and again under my own eyes."

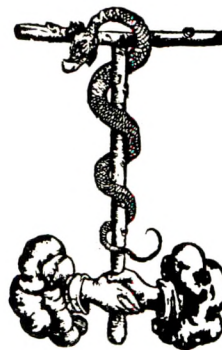
Gilbert studied the lines of force, or "effluvia" as he called them, around a



FIG. 1. William Gilbert (1540-1603).

G V I L I E L M I G I L
B E R T I C O L C E S T R E N -
S I S , M E D I C I L O N D I -
N E N S I S ,

D E M A G N E T E , M A G N E T I -
C I S Q V E C O R P O R I B V S , E T D E M A G -
n o m a g n e t e t e l l u r e ; P h y s i o l o g i a n o u a ,
plurimis & argumentis, & expe-
rimentis demonstrata.



L O N D I N I

E X C V D E B A T P E T R Y S S H O R T A N N O
M D C .

FIG. 2. Title page of Gilbert's "De Magnete."

small magnetic needle which was balanced upon a pivot. In performing these experiments he discovered magnetic induction and magnetic conductivity and many other similar phenomena. He also perceived that the ordinary magnetic compass needle points toward the north because the earth is a great magnet and not because the needle is "attracted by the stars." He therewith discovered terrestrial magnetism. In order to study the distribution of this magnetism, he experimented with a magnetic needle upon his "terrella" (Fig. 3) which was a large sphere of loadstone, the Neo-Latin name for which he originated.

Gilbert re-discovered the frictional electricity and the "electrical" properties of amber which were known from ancient times, and in addition he found a series of other materials such as sulphur, glass, resin, sealing wax and many crystals which,

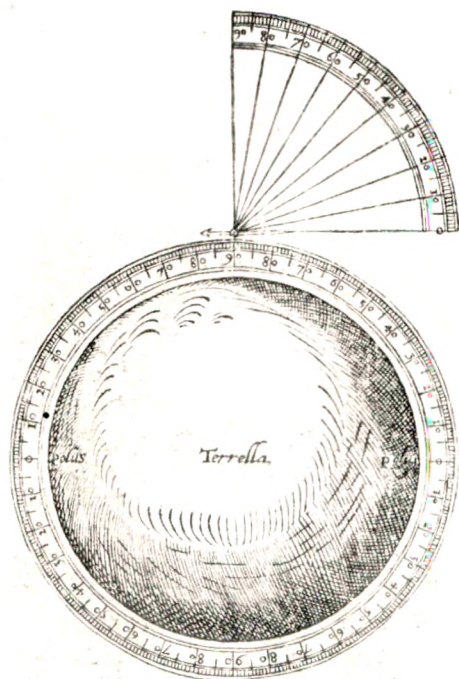


FIG. 3. Gilbert's "Terrella."

when rubbed, also possess "electrical" properties. Gilbert was the first one to use in his writings the term "electrical" when he says "vim illam electricam nobis placet appellare, quae ab humore provenit." He also found that, unlike metals attracted by a magnet, the materials mentioned before when rubbed attract only small particles and also leave the attracted particles unchanged. He studied the behavior of rubbed bodies at various temperatures, degrees of humidity, etc. Gilbert explained these differences between the effects of the magnet and rubbed resin on the basis of his "effluvia" theory: "The difference between magnetics and electrics is that all magnetics run together with mutual forces; electrics only allure," a theory which was considered correct for many years. He thought that electrical attraction took place in the same manner as the attraction of cohesion. Two electrified bodies act upon each other by means of their "effluvia," excited by friction. Curiously enough, he

did not observe electrical repulsion. Nicolaus Cabaeus, a Ferrara Jesuit (1587-1670), was the first to record the phenomenon of electrical repulsion in 1629. To measure electrical attraction Gilbert devised a kind of electroscope which he called a "versorium." It consisted of a thin metal needle suspended in a horizontal plane so that it "could be attracted like a compass needle."

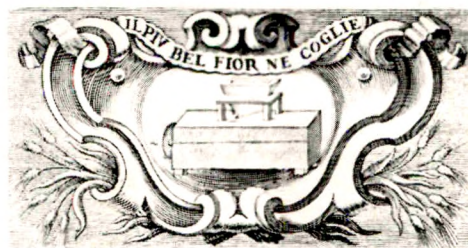
Gilbert's experiments were of fundamental significance. He was not only the first, but was also one of the most successful investigators in the field of magnetism and electricity. Queen Elizabeth acknowledged the significance of his work and granted him an annual pension for his philosophical studies. Gilbert died on November 30, 1603, from the plague. He is buried in Colchester, where his monument still stands in the Holy Trinity Church.

LEZIONI ACCADEMICHE D' EVANGELISTA TORRICELLI

Mattematico, e Filosofo

**DEL SERENISS. FERDINANDO II.
GRAN DUCA DI TOSCANA**

Lettore delle Mattematiche nello Studio di Firenze
E ACCADEMICO DELLA CRUSCA.



IN FIRENZE M. DCC. XV.
Nella Stamp. di S. A. R. Per Jacopo Guiducci, e Santi Franchi.
Con Licenza de' Superiori.

FIG. 4. Title page of Torricelli's "Lezioni."

After his death Gilbert's brother, who had the same name, published his brother's latter work in Amsterdam in 1651 under the title "De Mundo Nostro Sublemari Philosophia Nova." Priestly said of Gilbert's work in his famous book "The History and Present State of Electricity, 1767": "Such were the discoveries of our countryman, Gilbert, who may justly be called the Father of electricity, though it be true that he left his child in its very infancy." Another Englishman, Dryden, spoke in similar vein about the great value of Gilbert's work a hundred years after its publication, "Gilbert shall live till loadstones cease to draw, or British fleets the boundless ocean awe." Lord Kelvin called Gilbert's work, "One of the finest examples of inductive philosophy that has ever been presented to the world." Gilbert's experiments had without doubt a highly beneficial influence upon the work of his contemporaries and successors. He bequeathed his famous collection of instruments, globes, minerals and books to the College of Physicians, but his collection unfortunately was destroyed in the great London fire of 1666.

Since we are particularly interested in the work of Roentgen's "scientific forefathers" we must limit our discussion to those successors of Gilbert who worked on problems of magnetism and electricity and whose work eventually led to the development of the high tension apparatus which the Würzburg savant used in the nineteenth century in his experiments. But we also must review the numerous attempts to create an "empty space" which eventually led to the construction of the vacuum tubes which formed such an important part of the armamentarium of the Würzburg physicist. The development of these apparatuses often went hand in hand, and many a scientist worked at the same time on the improvement of some electrical apparatus and on the creation and perfection of high vacuum tubes.

The Italian, Evangelista Torricelli (1608-1647), was among those who first at-

tempted to create an "empty space," that is, to investigate the basic principles of removing air from an air-tight vessel, and thus he contributed to the development of the evacuated glass tube. Torricelli was born in Firenze. At the age of nineteen he



FIG. 5. Otto von Guericke (1602-1686).

was sent to Rome to study mathematics and mechanics. One of his teachers, Castelli, sent him to the great scientist, Galileo Galilei, after he had developed a theory for the explanation of some of Galilei's experiments; Torricelli worked with the blind Galilei for the last three months of the great scientist's life. He then was appointed successor to Galilei as Professor of Mathematics and Mathematician at the Academy of Florence under the patronage of the Prince Ferdinando II of Tuscany. He discovered the mercury barometer in 1643, and in working with it found in a 46-inch tube the vacuum at the top of the mercury column which subsequently was called the "Torricelli vacuum." The announcement of this important discovery

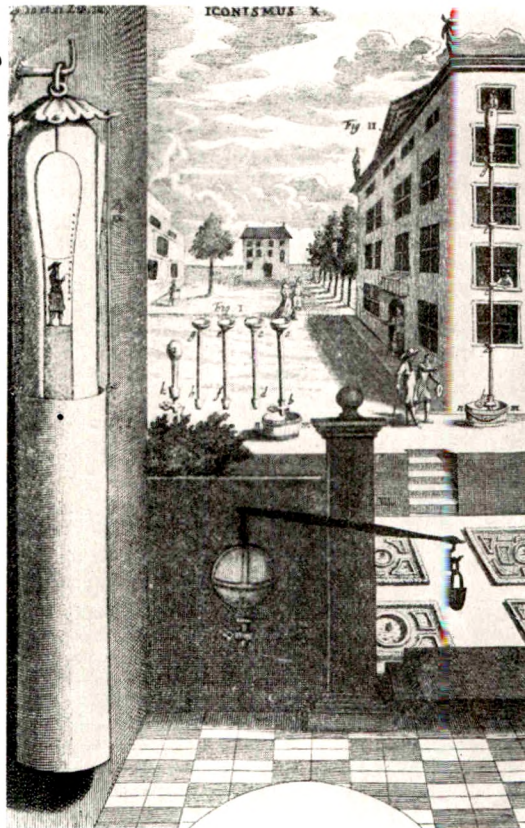


FIG. 6. Von Guericke's barometer.

was made in two letters written to his friend Ricci. The discovery of the Torricelli vacuum removed the conception of the "horror vacui" i.e. nature's abhorrence of a vacuum, which had existed for centuries. Torricelli died from pleurisy in Florence in October, 1647, at the early age of thirty-nine.

It was not until 1715, almost three-quarters of a century later, that the two famous letters which he had written to Ricci, and a description of his experiments and discoveries were first published by Tomasso Bonaventuria in Florence under the title "Lezioni Accademiche." (Title page, Fig. 4.) Torricelli's observation of the influence of the atmospheric pressure, especially that the barometric pressure becomes less at increasing distance from the center of the earth, was soon proved to be correct by the French philosopher and

mathematician, Blaise Pascal (1623-1662), who, on September 19, 1648 (one year after Torricelli's death), asked his brother-in-law, Perrier, to carry a Torricelli barometer to the top of the Puy de Dôme in the Auvergne, a mountain 974 meters high. The barometric pressure on top was considerably less than that at the foot of the mountain. Pascal himself, who was lame, repeated the experiment on a small scale on one of the city gates in Paris.

About the same time, Otto von Guericke (1602-1686) (Fig. 5) devoted himself to the study of similar problems. He was born on November 20, 1602, the son of an old Magdeburg family. He studied law in Leipzig, Jena and Leyden. At the latter university he was also attracted by lectures on physics and mathematics. Later he found time enough for research in spite of his

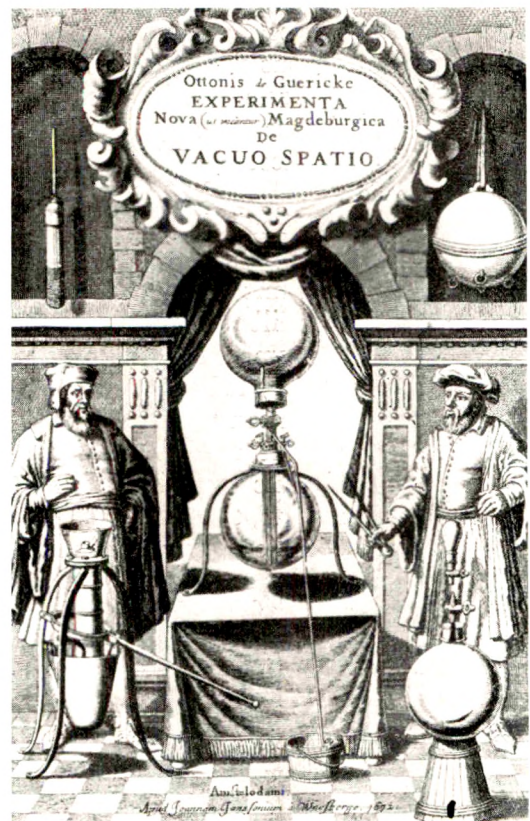


FIG. 7. Air pumps on title page of von Guericke's book.

strenuous administrative activities in the city of Magdeburg which had been completely destroyed in the Thirty Years' War. Von Guericke was a very gifted investigator and was one of the first to break with the old scholastic school. "Oratory, elegance of words, and fluency of debating are of no value in natural sciences" were his words and he attempted to answer by experiment many scientific questions. Yet the debates of the philosophers on the existence or non-existence of a vacuum aroused his interest and soon he worked on an apparatus to create a vacuum. He started out to work on the principle of the barometer and built himself a water barometer 60 feet high outside his house. He placed a small wooden figure on the top of the column of water in the barometer, the out-stretched hand of which pointed to a scale to indicate the barometric pressure, thus predicting changes in the weather (Fig. 6). This ingenious apparatus brought the inventor into disrepute as a sorcerer. Without knowledge of Torricelli's work, von Guericke made many experiments similar to those of the Italian scientist. It was not until 1654 that the monk Valerianus at the Reichstag of Regensburg called von Guericke's attention for the first time to Torricelli's experiments.

Soon the barometric experiments were followed by attempts to create an "empty space" in a different manner. About 1646 von Guericke constructed his first real air pump and in 1663 he made considerable improvement on his first crude apparatus (Fig. 7). The improved pump consisted of a vertical cylinder in which the piston could be moved up and down by means of a lever. An automatic leather valve replaced the stopcock which he used on his first apparatus. He also attempted to obviate the disagreeable properties of the "dead space." Von Guericke made many demonstrations of how an "empty space" might be produced and of the tremendous atmospheric pressure upon an evacuated container. His best known experiment is that of the "Magdeburg hemispheres,"

which was demonstrated to Emperor Ferdinand III and the Princes who had assembled at the Reichstag in Regensburg in 1654 (Fig. 8). At that time he illustrated the outside air pressure on the evacuated hemispheres which were about 20 inches in diameter by showing that two teams of eight horses were unable to pull the hemispheres apart, but as soon as air was admitted to the evacuated space, the hemispheres fell apart.

It is of interest to note that after the Regensburg meeting some of von Guericke's original apparatus was taken to Würzburg, and that the report of the experiments was publicly made known by his friend Caspar Schott in his "*Mechanica Hydraulica-Pneumatica Experimentum Novum Magdeburgicum*, 1657," and later on in "*Technica Curiosa*, 1664," and that it was from this same city that the news of the discovery of the roentgen rays was given out some two hundred years later. In his inaugural speech as Rector of the Würzburg University in 1894, Professor Röntgen called attention to Caspar Schott who was one of his predecessors in the chair of physics at the Würzburg University.

"Caspar Schott was born in 1608 in Königs-hofen. He studied in Würzburg, but being a Jesuit, he was forced to flee before the invasion of the Swedes and found a position as teacher in Palermo. About 1655 he returned to Würzburg as Professor of Mathematics at the Gymnasium which at that time was connected with the University and he kept this position until his death in 1666. Schott followed in the footsteps of Kirchner who was his teacher, but he limited his studies to physics, mathematics and some medical subjects, the results of which were published in ten voluminous tomes. These publications made his name famous, though they contained very few important discoveries or original investigations. '*Mechanica Hydraulica-pneumatica*' is one of most interest to physicists and was published in 1657. It is the first description of the extremely important invention of the air pump which was made about 1646 by Otto von Guericke, the Burgomeister of Magdeburg. The air pump of von Guericke and the

barometer of Torricelli were of fundamental importance because the investigations on the properties of various gases which soon followed were dependent upon them. It was really Schott's book which caused Boyle, the English physicist, to initiate his important experiments on the elasticity of atmospheric air. Schott was the father confessor of Prince-Bishop Johann Philipp von Schoenborn who was one of the most intelligent and most active princes of his day. He had seen the experiments which von Guericke demonstrated in 1654 before the Princes at Regensburg. He was convinced of the importance of the discovery but was too impatient to await the construction of new apparatus, so he bought the whole collection of von Guericke and transported it to Würzburg. The experiments were then demonstrated to the Professors and invited guests. It was on this occasion that Schott first saw the air pump and was permitted to use it for his own researches. Schott was probably the first to investigate the influence of various atmospheric pressures upon animal life. These observations

were his only contributions of importance. He could not convince himself that the old, erroneous idea of the 'horror vacui' had come to an end and he even seriously tried to defend this idea against von Guericke."

The publications of Schott, as well as the communications which went from mouth to mouth, made the work of von Guericke well known long before von Guericke himself finished a report of his results in March, 1663, and recorded them in seven books which were dedicated to the Grand Elector. The title of these books was "Ottonis de Guericke, Experimenta Nova (ut vocantur) Magdeburgica de Vacuo Spatio" (Fig. 7). However, this work was not printed until 1672 in Amsterdam due to the illness of the author and to the difficulty in finding a publisher. Even then, von Guericke did not receive a fee for his work, though he had spent about 20,000 thaler for his experiments. The publisher



FIG. 8. Demonstration of von Guericke's Magdeburg hemispheres.

hesitatingly gave him only a few free copies.

Other experiments of von Guericke must also be mentioned because they formed the basis for the construction of the electrical apparatus which later played such an important rôle in the discovery of the roentgen rays. Von Guericke constructed an electrical machine which consisted of a rotating sulphur sphere against which he pressed one of his hands. The sphere had been made by pouring sulphur into a glass globe which was broken away after the sulphur hardened. The rotation of the sulphur sphere with the dry hand pressed against it, yielded static electricity of a potential high enough to produce phosphorescent light and brush discharges, or even small sparks. Such sparks, which actually were the forerunners of electrical illumination, were observed first by the philosopher Leibniz in 1672, while using a von Guericke apparatus, but to von Guericke belongs the credit for first having observed electric light phenomena.

Von Guericke, stimulated by Gilbert's book, studied many electric phenomena with his apparatus, such as attraction and repulsion, which latter appearance he observed for the first time—independently of the monk Cabaues—conductivity, the effect of sharp points on static electricity, etc. He thereby established many of the fundamental principles for the static machine which was developed later and which was based on these observations. It must be stated, however, that, like Gilbert, von Guericke sometimes speculated beyond the realm of fact. For instance, he believed that the earth was a great electrical machine which produced electricity by the friction of the rays of the sun while being turned "by the hand of the Almighty."

The electrical experiments of von Guericke did not cause the same sensation that his vacuum experiments had created. His later years generally were saddened by the ingratitude of his fellow citizens whose narrow-mindedness made them unappreciative of the tremendous work which he had been doing for his home town. He gave up

his Magdeburg office in 1681 and died at the home of his son in Hamburg five years later, on May 11, 1686, at the ripe age of eighty-four.



FIG. 9. Robert Boyle (1627-1691).

Von Guericke's experiments created great interest and were repeated in many places. A contemporary scientist, the Englishman, Robert Boyle (Fig. 9) who was born at Lismore, in 1627, and died in London, in 1691, carried on similar investigations. Boyle was one of the founders of the "Invisible College" which later became the "Royal Society of London for Improving Natural Knowledge." He declined, however, the presidency of this Society in 1680, for religious reasons. Boyle was successful in solving many important physical and chemical problems. He acquainted himself with most of von Guericke's experiments from the publications of Caspar Schott as well as through personal communications. With his assistant, Robert Hooke, he improved von Guericke's air pump or "pneumatic engine" as he called it, and added

the pinion movement to it. The result was the improved pump "*Machinae Boyleana*" completed in 1659, which was followed later by still more improved types by Hooke and Papin and by Boyle himself. With these machines, Boyle repeated the experiments of Torricelli and Pascal, and studied the behavior of gases when enclosed in glass tubes and made many important observations. The gas law which bears his name, and which he formulated in 1661, is well known. He published many of his results under the title "*New Experiments, Physico-Mechanical upon the Electricity and Weight of Air and their Effects*," in 1659, which was long before von Guericke's book appeared. Boyle in 1676 made the important observation that electrostatic effects of rubbed amber and magnetic effects were also effective in a vacuum. His numerous experiments connected with his observation appeared in another important publication, "*Experiments and Notes about the Mechanical Origin or Production of Electricity*, 1675," in which he not only described many of his experiments on electrical attraction but also discussed the various hypotheses on electricity which were current at that time, notably those of Cabaeus, Browne, Gas-sendi, Carterius, and others.

Boyle came from a prominent family. His father, Richard Boyle, later became the Earl of Cork and was a good friend of Cromwell. Young Boyle was one of fifteen children. As was customary in those days, he traveled extensively in Europe during his early manhood and was in Florence at the time of Galilei's death. He was rather frail and had to take good care of his health. At the age of twenty-eight he settled in Oxford and devoted his entire time to his scientific and religious studies. He died in December 31, 1691, and was buried in the Abbey. After his death all of his work was published in six volumes "*Opera Omnia Philosophica et Chemica*."

The great scientist, Isaac Newton, was born in Woolsthorpe on December 25, 1643, and died in London on March 20,

1727. In addition to other studies in electricity he also built in 1675 an electrical machine with a rotating glass sphere with which he made a large series of important experiments. An interesting observation, made by him in the course of a cleverly arranged experiment was that one side of a glass plate could be charged electrically by rubbing the other side with a cloth. Priestley in his book on "*Electricity*" in 1769 described this experiment of Newton's as follows: "Having laid upon the table a round piece of glass, about two inches broad, in a brass ring, so that the glass might be one-eighth of an inch from the table, and then rubbing the glass briskly, little fragments of paper laid on the table, under the glass, began to be attracted, and moved nimbly to and fro."

Newton sent an account of this experiment to the members of the Royal Society in 1675. After several failures, the attempts of the members to repeat the experiment were successful, and the Society formally returned its thanks to the great physicist.

Francis Hauksbee, the elder, who died in 1713, Curator of Experiments to the Royal Society and a countryman of Boyle and Newton, became very much interested in the experiments in electricity of these scientists as well as in those of Gilbert and von Guericke. He repeated many of them and built an electrical apparatus which was quite an improvement over von Guericke's sulphur sphere. He had discovered the electrical qualities of glass and therefore used a glass cylinder which was "turned by a winch and rubbed by hand." He improved it soon by using wool which rubbed against glass and later leather rubbing against amber. With these machines he discovered many new and curious phenomena, especially a variety of effects in regard to electrical attraction and repulsion and also electrical influence. Another phenomenon which he investigated with an electrical machine was an effect known under the name of "mercurial phosphorus." This effect consisted of a flickering lumines-

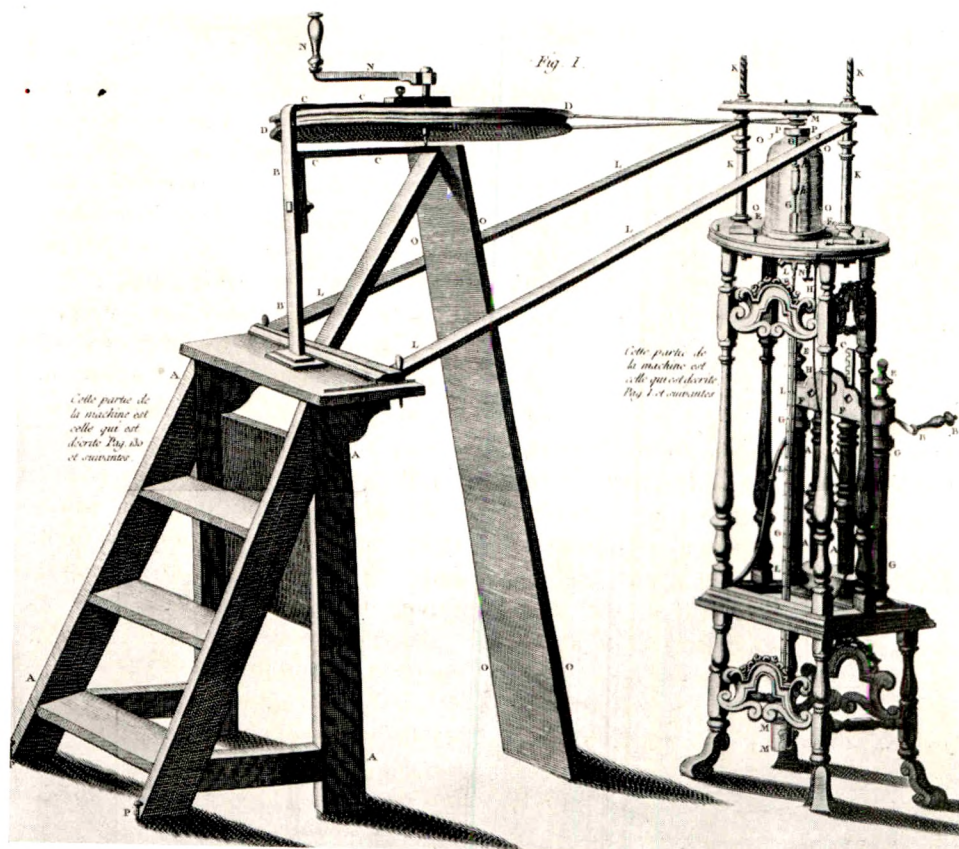


FIG. 10. Hauksbee's pump and electrical machine.

cence produced by shaking mercury in a so-called "shaking tube," i.e. an evacuated tube or a barometer. The French astronomer Jean Picard (1620–1682), a priest of Paris, had first observed this phenomenon while carrying a barometer in the dark to the Porte Saint Michael in Paris. Hauksbee suspected the luminescence as being of electrical nature though he did not realize that the glass of the tube was in any way related to the production of the "strange light." In working with his electrical machines he realized soon, however, phenomena which were very similar to the "mercurial phosphorus" and that they were due to the friction of the rubber or leather against the glass cylinder. He deduced from these observations that the mercurial phosphorus effect was similarly due to the friction of the moving mercury against the glass walls, but was under the impression

that electricity came from an "electrical fire" enclosed in the bodies.

He proceeded a step further in studying these light phenomena, and following Boyle's suggestion made about 1676, placed the electrical machine in a bottle which could be evacuated (Fig. 10). For this purpose he built a double cylinder air pump with many improvements over the von Guericke-Boyle type. Many and various were the new observations made by Hauksbee with this new apparatus. He not only produced brush discharges and therewith many effects of "electrical light," but he also obtained sparks larger than had ever been seen before in a laboratory. "Sometimes," he said, "I have observed the light to break from the agitated glass like lightning, and if a hand is held near the fricated glass a light will be seen to dart from it with a noise like that of a green leaf in a fire,

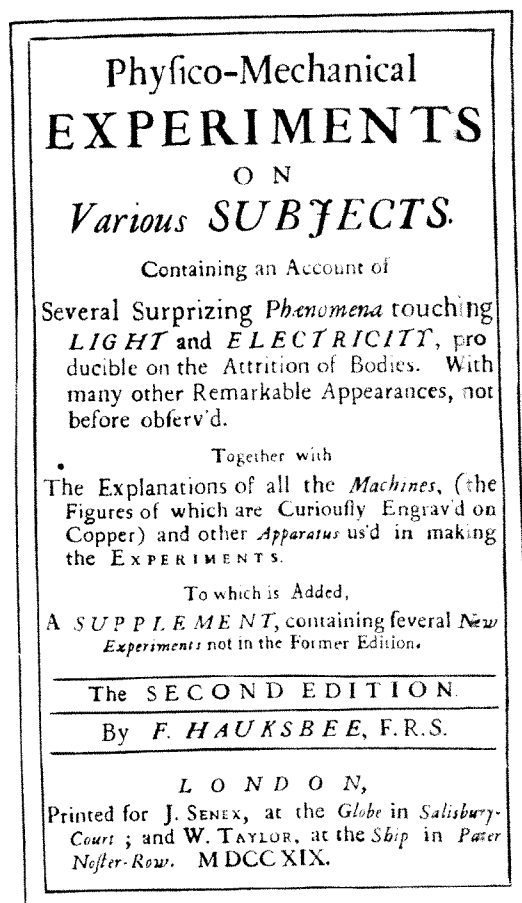


FIG. 11. Title page of Hauksbee's Book, "Physico-Mechanical Experiments" (Second Edition).

but not so loud." Interesting in this connection is one special experiment made by Hauksbee and described by Priestley as follows: "He lined more than half of the inside of a glass globe with sealing wax, and having exhausted the globe, he put it in motion; when, applying his hand to excite it, he saw the shape and figure of all the parts of his hand distinctly and perfectly, on the concave superficies of the wax within. It was as if there had only been pure glass, and no wax interposed between his eye and his hand." After the discovery of the roentgen rays in 1895 this experiment was occasionally cited to prove that Hauksbee at his time had already produced a type of radiation "penetrating all parts of the hand."

Many other experiments were tried by Hauksbee with his static machine but the idea of separating the static generator from the vacuum tube did not occur to him and was not realized until many years later. And in spite of the fact that he was a most prolific experimenter, he did not form a clear conception of the power of electricity in general or of the "distinction of bodies into electrics and non-electrics." He attempted, for instance, to use a metal sphere instead of glass or sulphur in his electrical machine and explained his negative results by the fact that "a small attrition is not sufficient to put the parts of the metals into such a motion as to produce an electrical quality."

In 1709 he published part of his work in a book called "Physico-Mechanical Experiments on Various Subjects; Surprising Phenomena Touching Light and Electricity Producing on the Attrition of Bodies," and in 1719 his complete studies were published posthumously (Fig. 11). Hauksbee's excellent experiments on electricity were a most valuable confirmation and continuation of the theories and observations of his great countrymen, Gilbert, Boyle, and Newton. Hauksbee's birth date is not known; he first became known in 1704 and 1705 through his excellent experimental work presented to the Royal Society. He must have been born around 1680 for in 1754 M. de Bremond, who translated his "Physico-Mechanical Experiments" into French, remarks: "If one sees the great number of discoveries made by Hauksbee one would not think that he only worked for twelve or thirteen years."

The artificial production of sparks as demonstrated so beautifully by Hauksbee created quite a sensation all over the world. A contemporary of Hauksbee, William Wall, while working with Boyle in 1698 also noticed light and sparks while rubbing small pieces of amber against each other or by rubbing amber with wool. Wall compared these sparks and light with lightning and thunder when he said, "I got a pretty large piece of amber which I caused

to be made long and taper and drawing it gently through my hand, being very dry, it afforded a considerable light. The crackling is full as loud as charcoal on fire, and five or six cracklings, or more have been produced from one single friction, light always succeeding each of them. This produced light and crackling which seem in some degree to represent thunder and lightning." Wall must have had a peculiar conception of these experiments for he added, "The best time to carry out these experiments is when the sun is 18 degrees below the horizon." On account of his observations, Wall abandoned Gilbert's "effluvia" theory of electricity which even Hauksbee still upheld. Wall believed that electrical phenomena were in some way associated with light.

In 1720, another Englishman, Stephen Gray (1696-1736), a pensioner in the London Charter House and a very studious worker, found that electricity which manifested itself by "light and crackling noises" could be produced by rubbing hair, silk, linen, wool, paper, leather, wood, and other materials, from one body to another. He extended such experiments over a number of years and once said: "Although these effects are at present but in minimis it is probable in time there may be found out a way to collect a greater quantity of the electric fire, and consequently to increase the force of that power." In 1729, he made the important discovery that electricity could be conducted from one body to another through metallic wires or "non-electrics" as he thought. He was, therefore, the first to become aware of the difference between conductors and non-conductors. His first experiments in conductivity were made with a fishing rod and insulating glass rods; he succeeded in carrying the current a distance of 18 feet, and later as much as 34 feet. Together with his friend, Granville Wheeler, he then attempted to conduct the "electric virtue" through a hemp cord 800 feet long, but the experiment was unsuccessful until Wheeler had the idea to suspend the string on silk threads. The

conductor thus becoming insulated, the attempt was crowned with success. They also found that the "electric virtue" could be communicated to their line of communication without touching it. Gray presented his results to the Royal Society in a paper entitled "The Electric Property of a Glass Tube may be Conveyed to other Bodies so as to give them the same Property of Attracting and Repelling Light Bodies as the Tube has when Excited by Rubbing; and that this Property may be Transmitted to Bodies which are a long way from the Tube." The importance of this work lies in the fact that electricity thus was shown to be able to exist outside of a body. Besides these important discoveries, Gray also investigated many other problems of static electricity. For example, he studied its distribution within a body and attempted to determine a possible relationship between electric and magnetic forces. He studied carefully the effect of electric influence which had been described by Hauksbee. He made an isolating "resin cake" by melting a mixture of sulphur, wood and sealing wax into a cake. This cake would hold an electrical charge for a long time when kept under a glass cover. Of one of these resin cakes, he constructed an "isolating chair" (1732) which he used in a number of startling demonstrations with Gray Friar lads who were seated upon the chair. For example, he caused an electric spark to shoot from the nose of one of them by touching his foot with a rubbed glass rod. Some of Gray's explanations of the phenomena found were not quite as ingenious as his experiments. He imagined, for instance, that the amount of "electric virtue" depended upon the color of the charged subject. He said that the body, if suspended on blue lines retained its power of attraction for fifty minutes, on scarlet lines for twenty-five minutes and on orange colored lines for twenty-one minutes. During his last years and even on his deathbed, Gray left the sound foundation of experiment and speculated in the realms of philosophy.



FIG. 12. Abbé Nollet (1700-1770).

Many of Gray's experiments were repeated by one of his contemporaries, Charles Francis de Cisternay du Fay (1699-1739), a Frenchman who was the director of the Royal Gardens in Paris and a member of the Paris Academy of Science. Du Fay's most important contribution to electrical science was the discovery in 1743 of the existence of two different types of electricity, the "vitreous" or "glass" and the "resinous" electricity. The former was produced when smooth glass, rock salt or crystals were rubbed with silk, and the latter when silk or paper was rubbed with wool. Du Fay described this discovery in the following words:

"Chance has thrown in my way a universal and remarkable principle which casts a new light upon the subject of electricity. The principle is that there are two distinct kinds of electricity, very different from one another; one of which I call vitreous, the other resinous electricity. The first is that of glass, rock crystal, precious stones, hair of animals, wool and many other bodies. The second is that of amber, copal, gum lac, silk, thread, paper and a vast

number of other substances. The characteristics of these two electricities is, that they repel themselves and attract each other. From this principle one may easily deduce the explanation of a great number of other phenomena; and it is probable, that this truth will lead us to the discovery of many other things."

To prove the difference between these two types of electricity, du Fay constructed an electroscope which was similar to the "versorium" described by Gilbert. When this instrument was charged with glass electricity and then a rubbed resin rod was brought near it, the deflection of the filaments of the electroscope was decreased, and vice versa. He also could show that "communicated electricity" had the same properties as "excited electricity." Du Fay then went a step further and showed that all bodies, even metals, could be made "electric" by heating and then rubbing them; they must, however, be suspended on insulating silk threads in order to stop the electric charge from being dissipated. He furthermore introduced a series of improvements in the construction of electri-

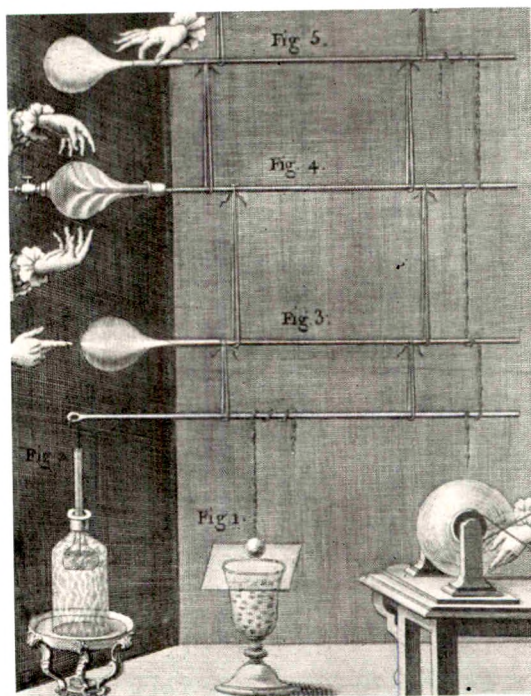


FIG. 13. Abbé Nollet's electrical machine and "egg."

cal apparatus. Du Fay had no satisfactory explanations for the important discovery of the two types of electricity and generally received more recognition in Germany than in his own country or in England. The last of his papers appeared in 1737 in the Memoirs of the Academy. He died of small-pox in Paris in 1739 at the early age of forty-one years. His many investigations were published in a series of memoirs which appeared in the transactions of the Academy in the years 1732 to 1737.

Another important advance in the knowledge of electricity was due to another Frenchman, Jean Antoine Nollet (1700-1770) (Fig. 12), who was the son of a farmer and became a member of the Royal Society and the French Royal Academy. Nollet, who had collaborated with du Fay in many of his experiments, became a teacher of science in the Royal House, an Abbé and Professor of Physics of the University of Navarre and teacher at the Artillery and Engineering School of Paris. Abbé Nollet carefully studied the work of

LETTRES SUR L'ELECTRICITE.

*Dans lesquelles on examine les dernieres
Decouvertes qui ont été faites sur cette
Matiere, & les conséquences que
l'on en peut tirer.*

Par M. PAbbé NOLLET, de l'Académie Royale
des Sciences, de la Société Royale de Londres, de
l'Institut de Bologne, & Maître de Physique de
M. LE DAUPHIN.



A PARIS,

Chez HIPPOLYTE-LOUIS GUÉRIN, &
LOUIS-FRANÇOIS DELATOUR, rue
S. Jacques, vis-à-vis les Mathurins,
à S. Thomas d'Aquin.

M. D C C. L I I I.

Avec Approbation & Privilège du Roi.

FIG. 15. Title page of Abbé Nollet's "Lettres sur l'Electricite."

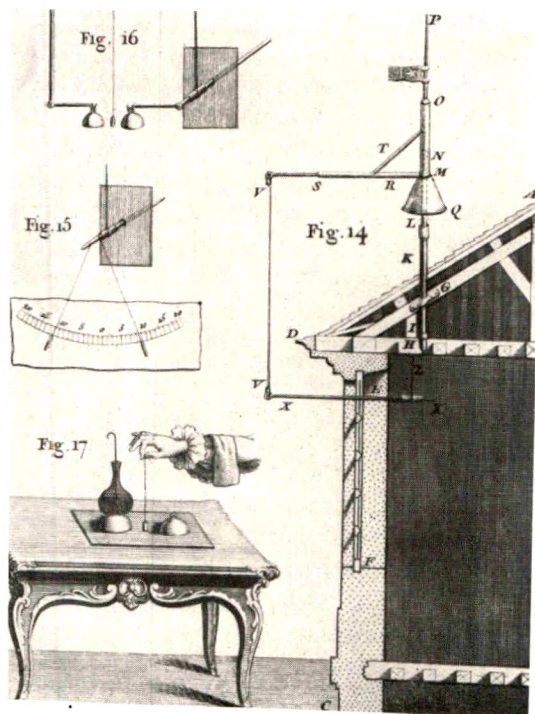


FIG. 14. Abbé Nollet's electrical experiments.

von Guericke, Hauksbee, and others. He improved upon their experiments and instead of placing the source of the high tension within the evacuated vessel as Hauksbee had done, he placed it outside and led the high tension to the glass vessel by means of iron chains. He thus simplified considerably the apparatus for the study of the discharge through high vacuum (Fig. 13). The amount of electricity was measured by means of an electroscope which Abbé Nollet made by suspending two light strings that would separate when the instrument was charged (Fig. 14). The glass vessel with which he carried on his research was egg-shaped and it was therefore called the "electrical egg." This "electrical egg" was undoubtedly the fore-

runner of the Hittorf-Crookes tubes and therefore also of the roentgen-ray tube.

Abbé Nollet liked to demonstrate his electrical experiments to large audiences, because, as he said, "Some of these electric experiments were most successful if they

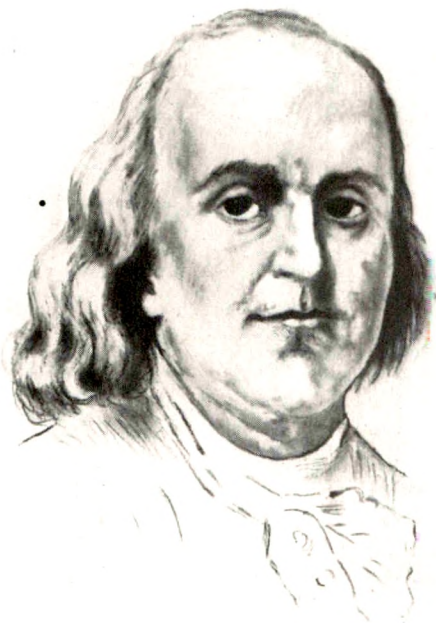


FIG. 16. Benjamin Franklin (1706-1790).

were shown before many people, provided that they did not come too close in their effort to see the experiments and provided that they were not sweating so much that the glass became humid." His experiments and theories were published in a large series of books and papers. In these he expressed an idea that electricity was a highly inflammable liquid which could be lit by the smallest shock. One of Nollet's most important books bears the title "*Recherches sur les causes particulières des phénomènes électriques*." His well-known "*Lettres sur l'Électricité*" (Fig. 15) which were published first in 1753 are also of great interest. In the second edition of this communication he stoutly defends his theories against those of Benjamin Franklin as can be de-

duced from the complete title, "*Lettres sur l'Électricité, dans lesquelles on examine des dernières découvertes qui ont été faites, and les Conséquences que l'on en peut tirer: où l'on soutient le Principe des effluences simultanées contre la Doctrine de M. Franklin, et contre les nouvelles Pretensions de ses Partisans*." However, Franklin's theories ultimately proved to be built upon a firmer foundation than those of Abbé Nollet. A contemporary of Abbé Nollet, Desaguliers did much to clarify the confusion in the large number of electrical observations, and in June, 1742, won a medal of the value of 300 pounds given by the Academy of Bordeaux for an excellent essay on electricity.

Benjamin Franklin (1706-1790) (Fig. 16), the great American statesman and scientist, made many important contributions to the science of electricity. Franklin came from a large family and was the tenth son of the soap maker, Josiah Franklin, who migrated from England to North America, in 1765. From a lowly station in life, Benjamin Franklin became a printer, writer, owner of a printing establishment, publisher of a newspaper, secretary of the Colonial Department, a postmaster, and occupied other important positions in the Colonial government, and was also a scientist of note. In his spare time he studied what was known about electricity at the time and soon advanced many theories of his own. According to Franklin's opinion, electricity, "a subtle matter" penetrated all nature in extremely thin dilutions and a body became electrified on account of an accumulation or of a deficiency of this thinly distributed electricity. For example, he thought that when friction was applied to a glass sphere the "electric fire" was "pulled" out of the material with which the friction was applied, but when the friction was stopped, the glass sphere gave up the electricity to another body which contained less electricity. If electricity was accumulated the "vitreous" electricity of du Fay appeared; if there was a deficiency in electricity the phenomenon of "resin-

ous" electricity was produced. Franklin therefore used the two terms positive and negative electricity but was under the impression that only one electrical matter existed. Franklin's experiments and theories relating to atmospheric electricity during thunder storms, especially his proof that lightning is an electric discharge, are best known. The studies on the diminution of electricity by points led to the construction of the lightning rod. His son collaborated in the famous experiment with the kite which in June, 1752, was made as a proof of his theories of electricity in the atmosphere. This experiment confirmed an old opinion of his which he had expressed in a short note made on November 7, 1749, when he stated his belief that thunder and lightning were electric phenomena. A similar opinion had been ventured three years before by J. H. Winckler, Professor of Greek and Latin, of Leipzig.

Toward the end of 1745, the investigations of E. J. von Kleist, the Dean of the Cathedral, in Kammin, Pommern, became known. He had discovered the so-called "Kleist jar." In a letter to a friend on November 4, 1745, Kleist sent the following account of his discovery:

"When a nail or a piece of thick brass wire, etc., is put into a small apothecary phial and electrified, remarkable effects follow, but the phial must be very dry or warm. If a little mercury or a few drops of spirits of wine be put into it the experiment succeeds the better. As soon as this phial and nail are removed from the electrified glass, or the prime container to which it has been exposed is taken away, it throws out a pencil of flame so long, that, with this burning machine in my hand, I have taken above 60 steps, in walking about my room. When it is electrified strongly I can take it into another room and there fire spirits of wine with it. If, while it is electrifying, I put my finger, or a piece of gold, which I hold in my hand, to the nail, I receive a shock which stuns my arms and shoulders. When I place this phial and nail to a tin tube which I have, 15 feet long, nothing but experience can make a person believe how strongly it is electrified. It appears to me extraordinary, that when this phial and nail are

in contact with either conducting or non-conducting matter the strong shock does not follow. I have cemented it to wood, metal, glass, ceiling wax, etc., which I have electrified without any great effect. The human body, therefore, must contribute something to it. This opinion is confirmed by my observations, that, unless I hold the phial in my hand I can not fire spirits of wine with it."

A year later Cuneaus and P. van Mussenbroek (1692-1761), professors at the University of Leyden, built a similar jar at the University of Leyden. The description of the first experiments of the two Dutch physicists with their arrangement designed to collect and store static electricity is of great interest:

"A gun-barrel was suspended on silken strings, having one of its ends very near a glass globe, which was turned rapidly, while electricity was excited in it by friction with the hands. A wire was hung from the other extremity of the gun barrel, which dipped into a beer glass full of water, and held in the hands of one of the other gentlemen. After the globe had been driven for some time, the gentleman who held the beer glass approached his finger to the gun-barrel to draw a spark from it. The consequence was a shock, differing in violence according to the length of time that the globe had been turned."

Immediately after the discovery of the "Kleist" or "Leyden" jar, the attention of the whole world was directed to the wonderful and mysterious actions of these jars. Within a short time the experiments with Leyden jars were publicly exhibited for money in all the principal cities of Europe. Exaggerated reports about their curative actions were circulated. It is to Franklin's credit that he soon explained the actions of the Leyden jar on the basis of his own theories on electricity mentioned before. He says in one of his letters to Collinson:

"At the same time that the wire and top of the bottle etc. is electrified positively or plus, the bottom of the bottle is electrified negatively or minus, in exact proportion, i.e. whatever quantity of electrical fire is thrown in at top, an equal quantity goes out of the bottom. So

wonderful are these two states of Electricity, the plus and minus, combined and balanced in this miraculous bottle situated and related to each other in a manner that I can by no means comprehend! If it were possible that a bottle

A N
A C C O U N T
O F T H E
E X P E R I M E N T S

M A D E B Y

S O M E G E N T L E M E N of the
• R O Y A L S O C I E T Y,

In order to discover whether the ELECTRICAL
POWER would be fenfible at great Distances.

W I T H

An Experimental Inquiry concerning the
refpective Velocities of ELECTRICITY and
SOUND.

To which are added,

Some further Inquiries into the *Nature*
and *Properties* of ELECTRICITY;

Communicated to the ROYAL SOCIETY,
By WILLIAM WATSON, F. R. S.

L O N D O N:

Printed for C. DAVIS, over-againft. *Gray's-
Inn Gate, Holborn.* 1748.

[Price One Shilling and Six-pence.]

FIG. 17. Title page of Watson's book on electricity.

should in one part contain a quantity of air strongly comprest, and in another part a perfect vacuum, we know the equilibrium would be instantly restored within. But here we have a bottle containing at the same time a plenum of electrical fire, and a vacuum of the same fire; and yet the equilibrium can not be restored between them but by a communication without! though the plenum presses violently to expand, and the hungry vacuum seems to attract as violently in order to be filled."

On the other hand, Abbé Nollet who coined the name "Leyden jar" added it to his sensational demonstrations in public.

In the presence of the King, he killed small birds and animals by a discharge of the jar. He discharged a jar through 180 soldiers of the Royal Guard and also through the monks of the Parisian Convent of Carthusians who stood in a row 180 meters long and the whole company, upon the discharge of the phial, gave a sudden spring at the same instant of time and all felt the shock equally. Naturally the idea of using this newly found agent to cure certain diseases occurred to many experimenters. The effects were tried on paralytics, but without success. While the original Kleist jars were filled with water which acted as one electrode, they later were lined inside and covered with tinfoil, which was a suggestion made by the Englishman, Watson. Franklin explained again that the two tinfoil plates of the bottle contained electric charges of opposite polarity because the inside plate usually receives more than the ordinary amount of electricity and is, therefore, positively charged, while the ordinary amount of electricity on the outside cover is reduced and is a negative charge, but if the surplus of the positive charge of the inner plate is brought to the outer plate by a conductor, a spark occurs which is followed by a report.

Franklin's scientific experiments were conducted as a hobby. Both his scientific and governmental successes brought him honors, not only in his own country, but also abroad. His scientific contributions became of great significance in the development of electricity and were published in many collections, the most important of which are "Experiments and Observations on Electricity made at Philadelphia, 1751-1754, (London 1769)," and also his "Letters on Electricity." The first of these publications consists of several letters which Franklin wrote between July, 1747 and April, 1754, to Peter Collinson, a fellow of the Royal Society in London. How great the impression of these letters was can be seen from Priestley's words: "Nothing was ever written upon the subject of electricity which was more generally read,

and admired in all parts of Europe than these letters. It is not easy to say, whether we are most pleased with the simplicity and perspicuity with which these letters are written, the modesty with which the author proposes every hypothesis of his own, or the noble frankness with which he relates his mistakes, when they were corrected by subsequent experiments." Aside from all of his serious scientific work, Franklin was thoroughly human. The story of his electric dinner is still told today. "A turkey was killed by electricity, roasted on an electric fire, and the health of all famous electricians in England, Holland, France and Germany was drunk out of electrified glasses under the thunder of discharges of an electric battery."

Franklin died from a lung abscess on February 17, 1790. He wrote his own epitaph. It reads:

"The Body
of

BENJAMIN FRANKLIN, Printer
(Like the cover of an old book,
Its contents torn out,
And stript of its letters and gilding),
Lies here, food for worms;
Yet the work itself shall not be lost,
For it will (as he believes) appear once more

In a new and more beautiful edition,
Corrected and amended
by
The Author"

The work of Franklin made its impression upon contemporary scientists in the old and new worlds. First among these may be mentioned Sir William Watson (1715–1787), an Englishman, whom Priestley called "the most interested and active person in the kingdom in everything relating to electricity." Watson had heard of Franklin's idea of the lightning rod and introduced it in Europe in 1762. Long before this time, however, Watson worked extensively with Leyden jars. His first letters were communicated to the Royal Society in March and October, 1745. He tried to determine the longest distance through which the discharge from a Leyden jar could be transmitted through wires, and in July, 1747, made his famous experiment "to convey the electric shock across the river Thames, making use of the water of the river for one part of the chain of communication" (Fig. 17). In 1753 he constructed a glass tube three feet long which was evacuated by means of a Smeaton pump and through which he sent high

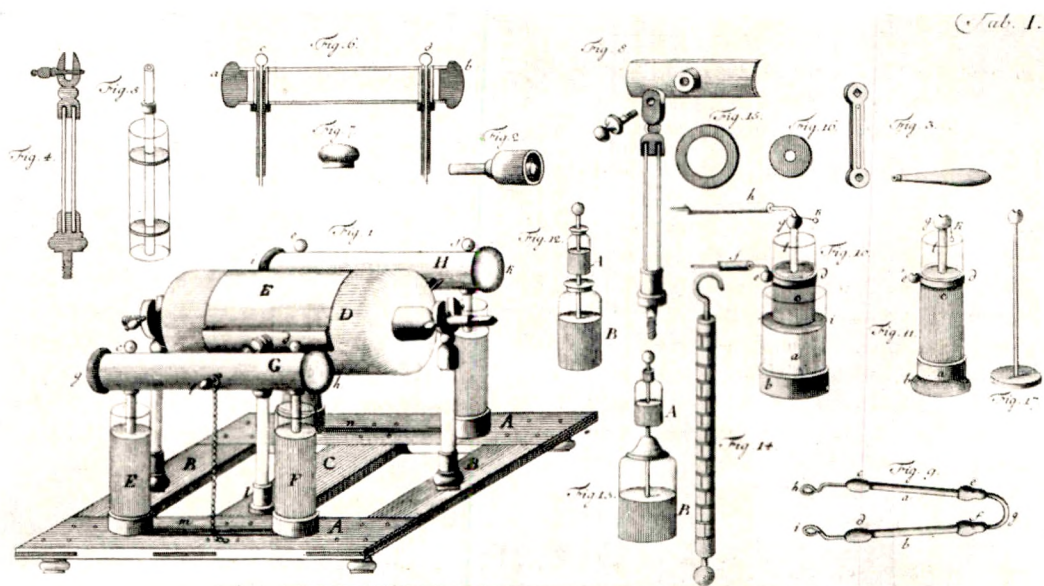


FIG. 18. One of Bohnenberger's "Electrisier-Maschinen."



FIG. 19. Luigi Galvani (1737-1798).



FIG. 19a. Alessandro Volta (1745-1827).

tension currents. His demonstrations of the manifold electrical and optical phenomena which were created by the discharges made a great sensation. Watson's experiments on conducting electrical shocks over long distances also brought him great admiration. Mussenbroek, one of the discoverers of the Leyden jar, wrote him on one occasion, "Magnificentissimis tuis experimentis superasti conatus omnium."

Another predecessor of Roentgen's was also an Englishman, William Morgan (died 1785), who perhaps was the first one actually to produce the x-rays. Morgan, in a lecture before the Royal Society in February, 1785, reported on his repetition of Torricelli's vacuum experiments. In performing these experiments he followed the advice of du Fay and cleaned the mercury in his barometer tube very carefully. In this way he was able to obtain a vacuum which was so high that he did not succeed in obtaining a discharge of the high tension through the tube. In one experiment a tube cracked and when the air slowly entered it,

Morgan observed a beautiful display of colors which changed continuously. This gave him the idea that it might be possible to estimate the vacuum in the tube by the various color changes. Morgan most probably produced roentgen rays in these experiments and his suggestion of studying the color range in a discharge tube in order to obtain an idea of the degree of vacuum was destined to become important in later years when vacuum tubes were more highly developed.

It is impossible to mention all the scientists who subsequently contributed to the knowledge of electricity or of the vacuum and to the improvement in apparatus. The German professors, C. A. Hansen of Leipsic (1693-1743), G. M. Bose of Wittenberg (1710-1761), F. H. Winckler of Leipsic (1703-1770), and the Scotch Benedictine monk, P. Gordon (1712-1751), made many improvements in electrostatic machines and vacuum pumps, notably the substitution of the globe for the tube used since Hauksbee's time, the introduction of

mechanical rotation using a heavy wheel and a pedal arrangement, insulated conductors, substitution of the hand by a rubbing cushion with springs to excite the globe, the use of one and later of four cylinders. In 1746, B. Wilson (1712-1788), introduced the comb collector for the static apparatus. Further improvements were made by Bennet, Erasmus Darwin and G. C. Bohnenberger. It was especially Bohnenberger, a minister in a small German village, who was a most prolific worker with "Elektrisir-Maschinen." He wrote six extensive treatises on the history of these machines and notably on his own constructions (1784-1791) (Fig. 18).

But going back to Franklin's time we find that the many attempts to measure the amount of electricity by means of some type of electroscope as conceived by du Fay and Nollet were continued by two other Frenchmen, le Roi and Chevalier d'Arcy, who probably were the first to measure electricity quantitatively by means of an ingeniously constructed electrometer. John Canton (1718-1772) "an eminent electrician" in England also took up Nollet's idea and he used two small spheres of elderberry pith which were suspended on fine silk strings in a box so that when charged the two spheres repelled each other and the amount of separation could be taken as a measure of the electric charge. Canton was a successful experimenter and he made excellent observations on phenomena of electrostatic influence. His friction experiment made in 1753 with a glass rod which was polished on one side and roughened on the other is of fundamental significance. When this glass rod was rubbed with a piece of hard rubber, two different kinds of electricity were produced for the first time on one material, positive electricity on the polished surface, and negative on the roughened surface. Canton also made the suggestion that cushions of electric machines be covered with mercury-tin amalgam in order to increase their efficiency. Two other contemporaries of Canton belong to this group of scientists, J. K.

Wilcke (1732-1796), a Swede, who lived in Germany, and Beccaria of Italy. Both experimented with the phenomena of electrostatic influence similar to those investigated by Canton and they were able to solve many problems about which there was considerable uncertainty.

Thus far the electrical phenomena observed came from frictional electricity or from atmospheric electricity. The eighteenth century brought the knowledge of a new kind of electricity. Among its discoverers were notably two Italians, Luigi Galvani (1737-1798) (Fig. 19), and Alessandro Volta (1745-1827) (Fig. 19a) who distinguished themselves by important discoveries, and the Frenchman, Coulomb. Luigi Aloisius Galvani, born on September 9, 1737, at Bologna, originally prepared himself for a theological career but later acceded to the wishes of his parents and studied medicine. In 1762 he was appointed Lecturer in Anatomy and in 1775 Professor of Anatomy at the University of Bologna. His observations on the twitching of a frog's leg suspended by a copper hook to an iron rail, and the conclusions which he based upon this experiment are familiar to everyone. Galvani was of the opinion that the effects were due to the metallic connection between the outside negative electricity in the muscle and the inner positive electricity of the nerves. His first publication on these observations which he called "Animal Electricity" appeared in 1786 but he continued his experiments and five years later he published his famous thesis "*De Viribus Electricitatis in moto musculari commentarius*," which appeared in the *Memoirs of the Institute of Science* in Bologna in 1791, and a year later also in Modena. Most of his important experiments were made in November and December, 1780, and all through the year 1781. Galvani died on December 4, 1798, during his sixty-first year, in the house of his brother, Giacomo, at Bologna. He was heartbroken because the government of the Cisalpine Republic in April, 1798, had stripped him of all his offices and honors

since he would not render the oath of allegiance to the new government. Finally the government at the recommendation of Professor Aldini reinstated him at the University, but the great scientist was dead before the news reached him.

It was Galvani's great fortune to discover a new kind of electricity, though he himself erroneously thought that the tissue itself was the source. In his writings he expressed the hope that his observations would be studied further by prominent scientists of his time. This desire was soon fulfilled by Volta, his famous contemporary, who repeated a number of Galvani's experiments and penetrated still more deeply into the secret of the newly discovered source of electricity.

Alessandro Guiseppe Antonio Anastasio Volta, who continued Galvani's experiments so successfully, was born on the 18th

of February, 1745, at Como. He was made Professor of Physics at the Gymnasium of Como at the age of twenty-nine. Five years later he was offered the newly founded chair of Physics at the University of Pavia. Volta came in contact with many contemporary scientists, Davy, Arago, Lichtenberg, Lavoisier, Laplace, Priestley, and others, on his numerous journeys through Europe, and learned many new and important facts in his discussions with them. In contrast to his countryman, Galvani, he was on good terms with Napoleon Bonaparte who later invited him to Paris in 1801 to give a demonstration of his experiments on contact electricity and on his newly invented Volta pile. Many honors were heaped upon him there including a special gold coin struck with his image upon it.

(To be continued in September Issue)



MULTIPLE MYELOMA WITH SPINAL CORD INVOLVEMENT*

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THERE is seldom an opportunity to study the complete disappearance of a vertebra. One case we are reporting clearly demonstrates this phenomenon. Another unusual feature is the excellent palliative result obtained while observing the patient over a period of five years. This would have been considered a solitary myeloma had not sufficient time elapsed wherein multiple lesions could be demonstrated.

REPORT OF CASES

CASE I. M.M., a mechanic, aged thirty-one, entered the University Hospital February 10, 1928, with a chief complaint of pain in the back. This had first been noted in the mid-lumbar region two years before. A kyphosis was noticed by the patient's wife eight months before entrance.

In November, 1927, the patient had been referred by his physician to Dr. S. E. Sanderson of Detroit for roentgen studies. These revealed a destructive lesion of the third lumbar vertebra, and a diagnosis of myeloma was made.

The pain gradually increased in severity and

an area was noted on the right thigh which felt cold and at times as if the "skin were raw." One month before entrance, putting any weight on the spine was unbearable and he supported

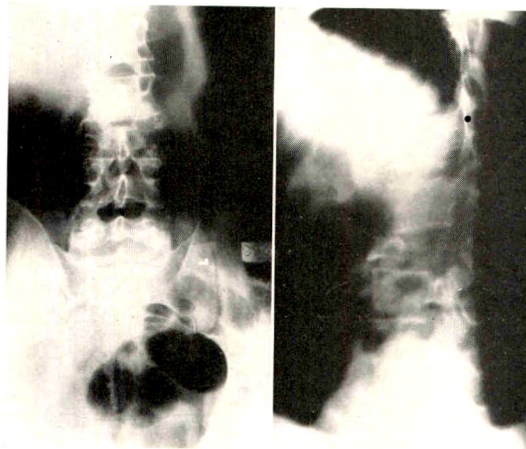


FIG. 2. February 11, 1928. Preoperative roentgenogram showing additional destruction.

himself in the sitting position with his hands. The wife stated that at times the pain was so excruciating he became delirious.

The past history was essentially negative. There was no history of operations or injuries. No nocturia, dysuria or incontinence. Little was known of the family history.

Examination revealed a well-nourished young adult male lying on his side with the knees drawn up apparently suffering great pain. There was a well-rounded kyphosis in the lumbar region.

The pupils were equal and regular, reacted to light and in accommodation. The thyroid gland was not palpable and there was no cervical adenitis. On chest examination there were no areas of dullness and no râles persisted after cough. The heart was not abnormal. The blood pressure was 128/80. There were no masses or areas of tenderness in the abdomen. The liver and spleen were not palpable.

Considerable wasting of both legs was pres-

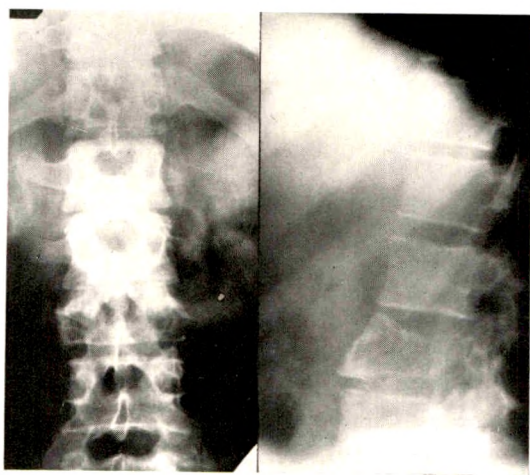


FIG. 1. November 25, 1927. Original films demonstrating destruction of third lumbar vertebra. (Courtesy of Dr. S. E. Sanderson.)

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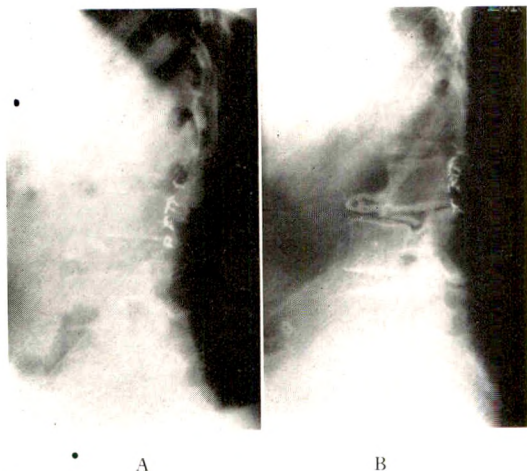


FIG. 3. A. April 5, 1928. Metallic densities are silver clips used at operation to control hemorrhage. B. May 3, 1930. Destruction continues.

ent. The knee and Achilles reflexes were active and equal. Babinski's sign was negative. The sense of motion and position of the toes was normal. There was an area of hypalgesia on the anterior aspect of the right thigh quite well localized to the second and third lumbar segments.

The blood Kahn reaction was negative. Hemoglobin, 84 per cent; white blood cells, 7,200. The urine was negative. No Bence-Jones protein reaction.

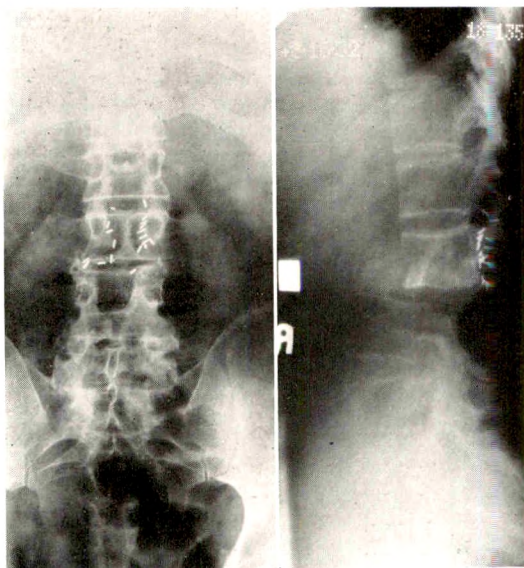


FIG. 4. August 16, 1932. Complete disappearance of third lumbar vertebra. Note second lumbar now rests on fourth.

Roentgen examination on February 14, 1928, revealed normal contour and alinement of the first two lumbar segments. The third lumbar segment was partially reduced in size and had



FIG. 5. August 16, 1932. Typical myeloma lesion in right humerus.

lost a large amount of its calcium content. It lay anterior to the second segment and a portion of its lamina had been destroyed, although its arch was preserved. The body of the fourth lumbar vertebra also lay anterior to a line drawn through the anterior portion of the first and second segments. Studies of the skull,

pelvis, ribs, lungs, right femur and tibia were entirely negative (P. M. Hickey).

Because of the severity of the pain and the area of diminished sensation, it was felt that nerve root involvement was present. Laminectomy was advised.

On February 15, 1928, under nitrous oxide ether vapor anesthesia, a midline incision was made by Dr. Max Peet with removal of the posterior spinous processes and laminae of the second, third and fourth lumbar vertebrae. Opposite the third lumbar the dura was much flattened and about twice its normal width from pressure of tumor anterior to the dura. This tumor passed laterally on the right so that it encircled the third lumbar nerve immediately after its exit from the dura. The veins anterior to the dura were enormously dilated and bled freely. The hemorrhage was controlled with silver clips and muscle grafts. The tumor around the third nerve and a portion of the tumor within the bed of the third lumbar was removed with a curette. The nerve roots of the third lumbar segment were pressed upon by the tumor at their entrance into the bony canals. The dura was opened, and the posterior roots of the second and third segments divided. The proximal and distal ends were caught with silver clips as the veins accompanying them were larger than normal. The dura was closed with a continuous silk suture. The muscles were closed in layers.

Postoperatively the patient's condition was poor and he was given 500 c.c. of 5 per cent glucose. He was placed upon a Bradford frame. The following day his condition was improved and he was turned by means of an anterior mould. A superficial pressure sore developed over the sacrum but healed rapidly. The patient was up in a wheel chair with a back brace, on March 18, 1928, and was walking about the ward in his back brace feeling perfectly well. The microscopic diagnosis was "typical plasma cell myeloma."

Three weeks after the operation the patient received a total roentgen dosage of 575 r (measured in air), quality 0.15 Ångström units, directly over the operative site with a field 10×15 cm. in four equally divided daily doses.

Subsequently he returned as an out-patient at intervals of a month to six weeks and received one-fourth of the above total dose with the same technique for a total of twenty-five treatments. This consisted of 3,375 r over ap-

proximately a four-year period, the last treatment being given in December, 1931. Check-up roentgenograms showed progressive disappearance of the third lumbar vertebra.

There was no further trouble until July, 1932, the patient having worked continuously as a mechanic and clerk. The brace was always

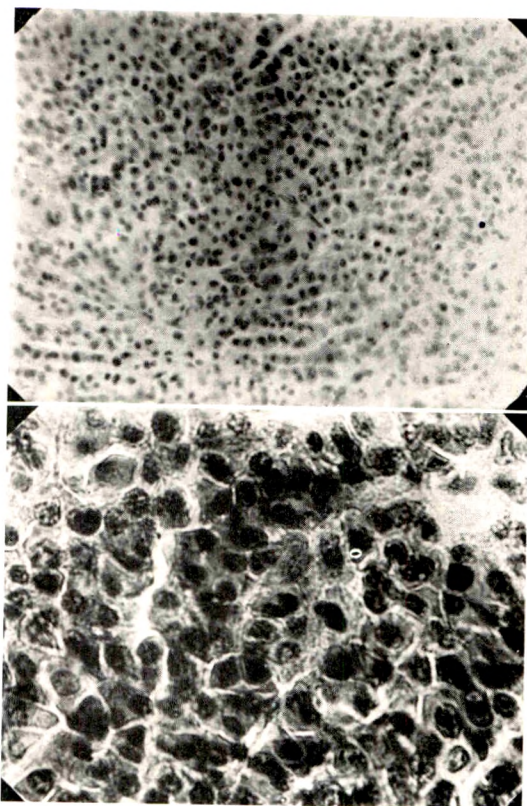


FIG. 6. Photomicrograph of plasma cell type of myeloma.

worn except at night. In July, 1932, the back-ache again commenced. The patient felt as if his "back was tired." In August, when walking, a sharp pain came on without warning. He supported himself to take the weight off the spine and was somewhat relieved although breathing was painful. He stayed in bed one week without pain and gradually got up. He noticed that he was free from pain at first but after being up several hours it was necessary to return to bed.

Roentgen examination of the spine now revealed involvement of the second and fourth lumbar vertebrae. The skull, ribs, right humerus and femur had the typical appearance of punched-out lesions of multiple myeloma.

The Bence-Jones reaction was positive. Blood smears revealed no gross abnormality. The hemoglobin was 80 per cent; red blood cells, 4,420,000, and white blood cells, 12,350.

Neurological examination by Dr. Waggoner revealed that the right knee and Achilles reflexes were normal. The left knee and Achilles reflexes were not obtained. Vibratory sense and sense of motion and position of the toes were normal. Sensation was almost completely lost in the distribution of the first, second and third lumbar segments, with slight diminution in the fourth and fifth lumbar; apparently none in the first sacral segment.

This diminution of sensation was certainly more extensive than could be accounted for by previous posterior root section so that further involvement of the cauda equina had developed.

On September 16, 1932, medium wave length roentgen therapy was recommended, using a cross-fire method to each side of the lumbar spine. After five treatments at weekly intervals the patient obtained complete relief of pain. Treatments were not given over the other skeletal lesions because of their multiplicity and freedom from pain. In July, 1933, he reported himself as symptom-free.

CASE II. C.M., a farmer, aged sixty, entered the University Hospital March 13, 1933, with a chief complaint of paralysis of both legs. The first symptom had come on six weeks before with a numbness of the feet which gradually spread to the nipple line. Pain had been noted shooting across both sides of the upper abdomen. There were no bladder symptoms.

On examination there was some voluntary movement of the left ankle, none of the right. The knee jerks were hyperactive. Plantar irritation gave a positive Babinski's sign on the right with no movement of the toes on the left. There was an almost complete sensory paralysis to the sixth dorsal segment. A complete subarachnoid block was demonstrated.

The urine was essentially negative, and there was no Bence-Jones reaction. Hemoglobin, 80 per cent; red blood cells, 4,670,000; white blood cells, 5,600.

Roentgen examination revealed a destructive lesion of the fourth dorsal vertebra. There was a small area of rarefaction in the right femur. The general physical examination gave no evidence of a primary malignancy and it was felt that the lesion was a myeloma.

Under local anesthesia, a laminectomy was performed (Dr. E. A. Kahn). Three laminae

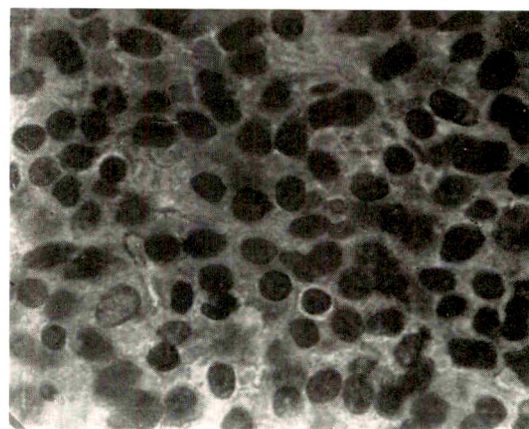


FIG. 7. Postoperative roentgenogram and photomicrograph of Case II.

were removed centering over the fourth dorsal vertebra. It was seen that the dura was pushed posteriorly by a grayish-black, rounded mass arising from the body of the fourth dorsal vertebra. The posterior spinal ligament was incised over the tumor and a small amount removed. The same afternoon the patient was moving both legs. In spite of a severe attack of facial erysipelas the patient was up walking in a Taylor back brace six weeks postoperatively. The microscopic report was "myeloma, probably myeloblastic in type."

One month after operation the patient received the following roentgen dosage: 650 r (measured in air), effective wave length 0.15 Ångström units, cross-firing the laminectomy site obliquely through each of two portals (one per day), 10×15 cm. in size.

The patient reported in July, 1933, that he was working daily and was free from pain.

We have found 3 other cases in the literature with spinal involvement subjected to laminectomy.

CASE I. A case is described by Wakeley³ of a man, aged forty-one, seen in September, 1927, complaining of "loss of power and sensation" in the legs. Laminectomy was performed by Sargent in January, 1928, extradural, soft vascular tissue being removed. The microscopic report was "plasma celled myeloma with fairly large cells."

The patient was symptom-free until October, 1929, when the symptoms recurred. He was given a course of roentgen therapy with improvement, though some weakness remained in the left foot. The outcome is not given in this case though he was still alive and about, November, 1931.

CASE II. Coley² reports the case of a man, aged fifty-six, who in 1922 complained of pain in the lumbar region and later severe abdominal pain shooting down the legs. He received high voltage roentgen therapy with considerable relief of pain. A year later there was an increase in pain with rapid development of paralysis. He was operated upon by De

Martel of Paris, a semi-cylindrical tumor being found which nearly encircled the cord. It was removed as thoroughly as possible and roentgen therapy given postoperatively. The paralysis and pain disappeared, though the patient never regained control of the bladder. Coley's toxins were used after multiple lesions had been demonstrated in the ribs, spine and chest. A year later there was no roentgen evidence of involvement of the skeletal bones.

There was in this case some disagreement as to the microscopic diagnosis though Coley reports it as myeloma. The patient was still alive and active in 1931.

CASE III. Cabot¹ reports the case of a laminectomy performed by Mixter for myeloma at the fourth dorsal vertebra. The patient was in extremely poor condition before operation with a respiratory paralysis necessitating the use of the Drinker respirator for a time. A complete motor and sensory paralysis extended to the sixth dorsal segment. A hemorrhagic cystitis was also present. The patient lived only fourteen days postoperatively so that the ultimate operative result could not be determined.

CONCLUSIONS

These cases clearly show the palliation obtained by laminectomy plus roentgen therapy in what is ordinarily considered a hopeless condition. With severe cord compression, laminectomy should always be performed before the therapy is given. This permits the establishment of a positive diagnosis and prevents further damage to the cord by swelling subsequent to irradiation.

REFERENCES

1. CABOT, R. Case Records of Massachusetts General Hospital. *N. England J. M.*, 1930, 203, 1090.
2. COLEY, W. B. Multiple myeloma. *Ann. Surg.*, 1931, 93, 77-89.
3. WAKELEY, C. P. G. Plasma-celled myelomatosis. *Proc. Roy. Soc. Med.*, 1931, 25 (*Clin. Sect.*), 22.



ABSENCE OF LEFT DIAPHRAGM ASSOCIATED WITH INVERTED THORACIC STOMACH

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THE presence of abdominal organs within the thorax, while not a common occurrence, is no longer considered a rarity. The following conditions are recognized:

1. Diaphragmatic hernia. Only a few cases reported until the end of the Nineteenth Century, but not an infrequent finding since the diagnostic use of roentgen rays has become universal. A review of all the cases in the literature would constitute quite a formidable task and would probably not include all the actual cases as many at present are not reported. The abdominal organs enter the chest cavity through a rent or defect in the diaphragm or through one of the regular openings which happens to be abnormally large. The organs are at times seen above the diaphragm, at other times they may be found within the abdomen, below the diaphragm. The latter fact accounts for the great discrepancy in incidence reported by various authors, as many hernias probably remain unrecognized if small or if not looked for.

2. Eventration of the diaphragm. The abdominal organs are not really in the chest cavity proper, but only appear to be in the thorax. The diaphragm is at all times above the abdominal viscera, being stretched and pushed up into the chest.

3. Thoracic stomach with short or long esophagus. In contradistinction to the other conditions mentioned, the esophagus does not go through the diaphragm. Either the duodenum or the pyloric portion of the stomach passes through the esophageal opening in the diaphragm. The stomach *at all times* is found in the chest cavity proper. Only 8 cases are so far reported in the literature.

4. Absence of left diaphragm. This was considered by some as almost incompatible

with life¹² but 12 cases to date have been reported in the literature, several in patients of advanced age.

Ordinarily, the differentiation between these anomalies is very simple. A very lucid description of the various conditions is given by LeWald.^{19,20} However, in practice it is not always easy to classify the cases correctly and errors of diagnosis are not infrequent. Eventration and hernia are most commonly confused and thoracic stomach is sometimes described as hernia. LeWald calls attention to just such an error. The left diaphragm is sometimes difficult or impossible to demonstrate roentgenologically so that one cannot be absolutely certain whether he is dealing with a thoracic stomach of the long esophagus type, with a large hernia or with a case of an absent left diaphragm. The case cited below presents such a difficulty. The most serious error, however, pointed out by many authors is that of mistaking the presence of the stomach in the chest for hydropneumothorax, as also happened in this case. Fortunately for my patient, the attempts at paracentesis were unsuccessful. Several extraordinary features in this case, besides its rarity, make it worthy of detailed report and discussion.

REPORT OF CASE

H. F., male, aged thirty-nine, born in Crimea, Russia, has always enjoyed good health. Upon careful questioning, however, it was brought out that, while he had no difficulty in playing all kinds of games with the boys, he could never keep up with them in climbing mountains or in any other particularly strenuous physical exercises. He nevertheless participated in all athletic sports without ill effects. His appetite and bowel action have always been normal. In 1914 he was drafted into the Russian army and was sent to the front.

* Read before the New York Academy of Medicine, March 15, 1932.

In January, 1915, while shooting in lying position on his abdomen on level ground, he was wounded in the lower back by a piece of shrapnel. He did not become unconscious, although he lost considerable blood and remained on the battlefield unattended for eight hours before the Austrians picked him up. He was in a hospital for several months until the wound healed. There was no paralysis or difficulty with the function of bladder or rectum. During his hospital stay, he was examined under the roentgenoscope to determine whether any piece of shrapnel was remaining in his back, but none was found. He observed, however, that the doctors in roentgenoscoping him showed great surprise and displayed unusual interest, demonstrating him to others on the staff. He could not understand their conversations, but knows that there was no fracture or other injury to the skeletal system found. After discharge from the hospital, he remained a war prisoner for three years and escaped back to Russia in 1918.

His life from 1914 on has been a very strenuous one. The Russian army at the front suffered a great deal from the cold winter, being poorly clothed and lacking shoes. The Austrians, according to his statement, fed the war prisoners

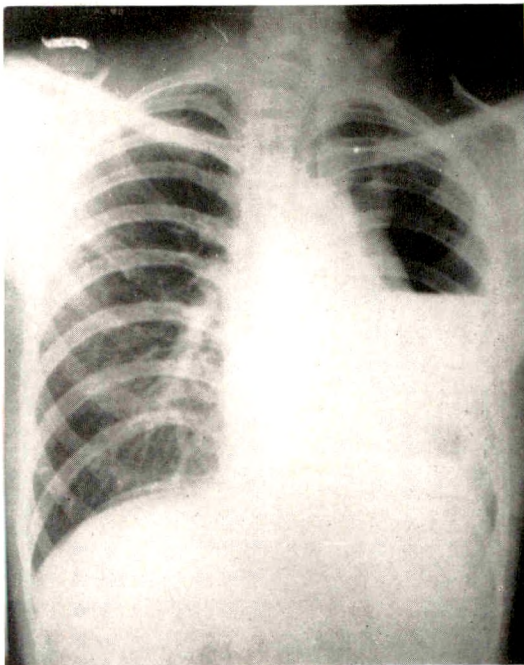


FIG. 1. Real hydropneumothorax. Note: heart not displaced, collapsed lung compressed against mediastinum, no lung tissue visible through gas.

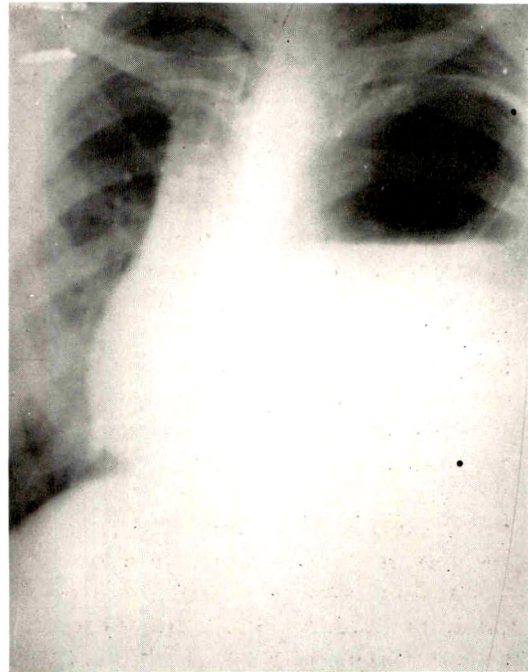


FIG. 2. False hydropneumothorax. Note: heart displaced to right, lung not collapsed, but surrounds gas-filled area, which occupies a central position. Some lung tissue can be seen through the gas. Stomach full.

badly and the camp hygiene was also bad. Upon return to Russia he was confined in prison as a political suspect for a long period of time, escaped to Constantinople where he lived for over a year, and in 1922, he immigrated to America. In spite of all the hardships, he was always in perfect physical condition.

In September, 1925, after a heavy meal, he suddenly developed an attack of marked oppression in the chest and was only relieved after a hypodermic injection of a narcotic and after copious vomiting. A similar attack occurred in April, 1926; it was associated with nausea, severe pain in the back, profuse perspiration and headache. Physical examination disclosed distant breath sounds in the left apex with few râles. There were elicited all the classical signs of hydropneumothorax of the left chest. The heart sounds were indistinct, the apex of the heart being diffuse and to the right of the sternum. He was again relieved after administration of a narcotic and after vomiting. A medical consultant was called in and he also found signs of fluid and gas in the left chest and confirmed the diagnosis of hydro-

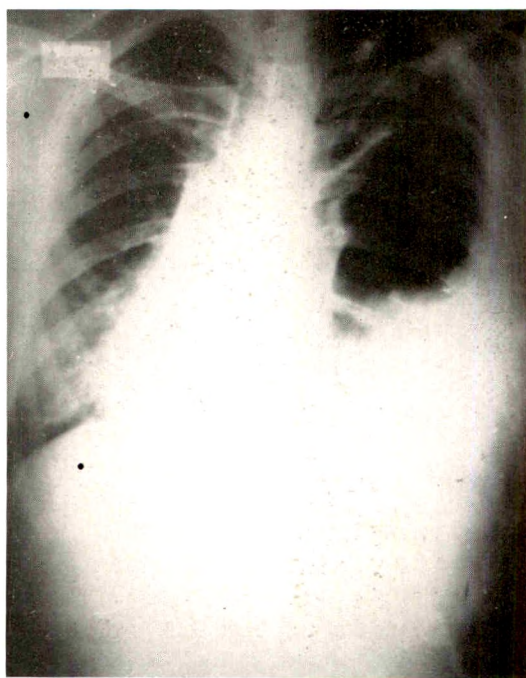


FIG. 3. Same as Figure 2 on fasting stomach. Note: no fluid level, large gas bubble.

pneumothorax. The question of etiology was not clear, whether it was due to pulmonary tuberculosis or was the result of the injury received in the war. He was referred to one of the best hospitals in New York for observation and treatment. I am indebted to Dr. I. Astrachan for the description of the first two attacks. The following is the communication the hospital sent me in answer to my inquiry:

"Date of admission to hospital—April 29, 1926.

Date of discharge from hospital—May 11, 1926.

Diagnosis: Hydropneumothorax; pulmonary tuberculosis.

Last known condition: Improved.

Roentgen Report, April 30, 1926:—Examination of the chest shows a collection of fluid in the left chest extending up to the level of the 4th rib anteriorly. Above this there is a pneumothorax extending up to about the 2nd rib anteriorly. Surmounting this the collapsed lung is seen, which shows no definite abnormality except perhaps some fibrosis.

The heart and mediastinum are displaced to the right side.

Final note: Patient with a negative past history, who enters with complaint of sudden sharp pain in the chest one month before admission. On physical examination there is evidence of hydropneumothorax

in the left chest which is confirmed on roentgen examination. Also some fibrosis seen at left apex. Sputum repeatedly negative for tubercle bacilli. Aspiration was repeatedly unsuccessful."

He left the hospital against advice, not wishing to submit to a third paracentesis thoracis as the first two were very painful.

The next attack occurred January 30, 1927, and was even more severe than the previous ones. His pulse was very weak and rapid, 130 per minute. He was relieved by vomiting of large quantities of recently ingested food and after an enema, and had to remain in bed for two days because of weakness.

The patient was referred to me for observation on March 22, 1927, by Dr. D. L. Elkind. He complained of no digestive disturbances except for excessive belching and some abdominal discomfort. His bowel action has always been regular. No dietary restrictions except for avoidance of red meats. Never used tobacco or alcoholics. Weight fairly stationary. No previous serious illness.

Physical examination was essentially negative, except for the chest findings. He looked

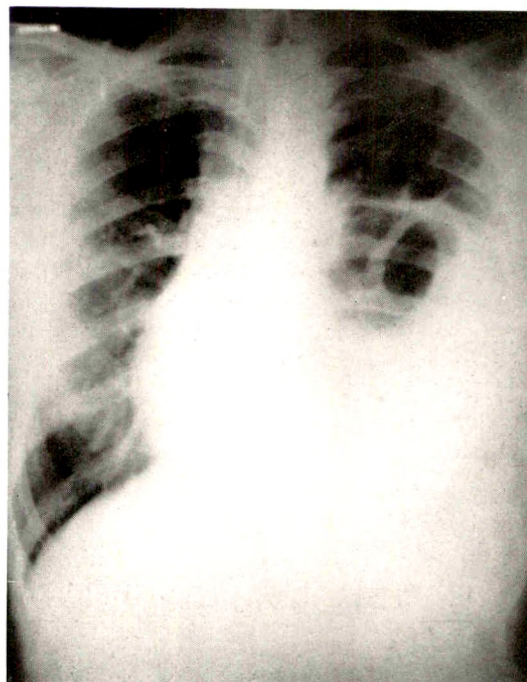


FIG. 4. Same as Figure 3 after introduction of stomach tube and aspiration of fasting contents. Note diminution of gas bubble and expansion of lung.

well-nourished, weighing 193 lb. Height 5' 11". Had good color but seemed to be somewhat short of breath. Configuration of chest symmetrical, rather round. The apex of the heart located one inch within the right nipple line and is diffuse. Percussion of the right side of the chest discloses an area of relative dullness extending to the right nipple, corresponding to the displaced heart. The percussion of the left side of the chest shows tympany in the upper half anteriorly as high as the clavicle. At other times it extends only to the 4th rib. There is dullness over the left lower chest.

Roentgenoscopic examination of the chest discloses a condition which very closely simulates hydropneumothorax. However, there is no evidence of compression of the left lung. On respiration there is paradoxical movement of the upper level of the gas-filled area noted. On close examination one can see some lung tissue through the gas. Re-examination after the aspiration of the stomach reveals a marked change in the picture. The gas area is considerably lower, the fluid having disappeared and the lung in the left chest becomes more prominent. This occurs only when the stomach is emptied by means of a tube, but the fasting

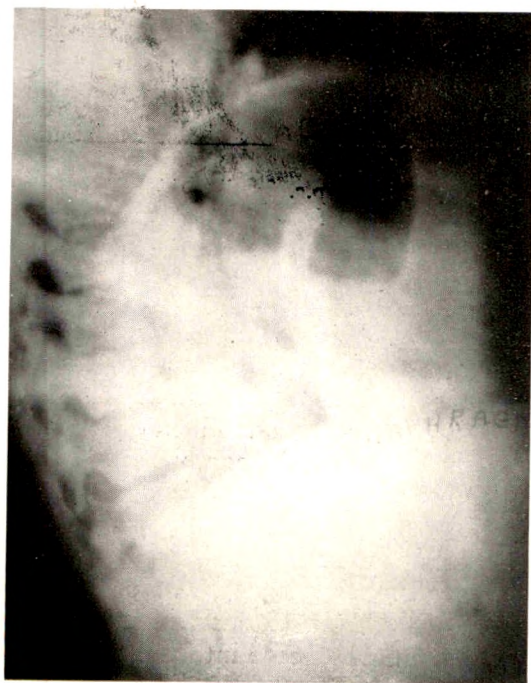


FIG. 5. Lateral view. Fasting stomach. Only right diaphragm can be made out.

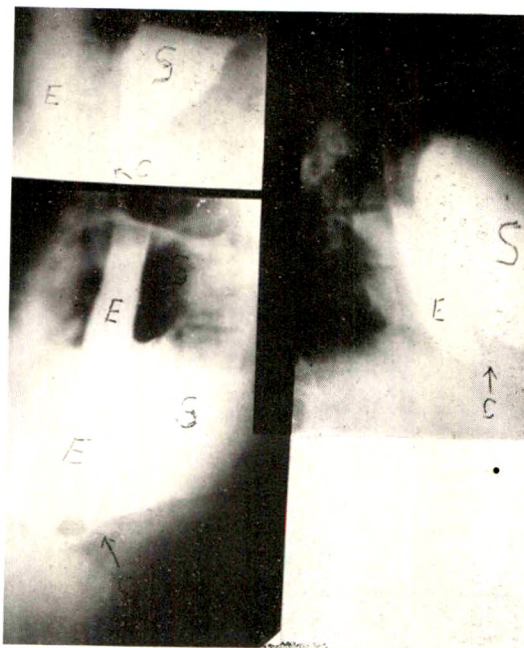


FIG. 6. Stomach in various stages of filling. Note water-trap appearance of esophagus with fluid level about the same as in the stomach.

stomach shows a very large gas bubble. The left diaphragm cannot be seen and the left base is quite dense (Figs. 1, 2, 3, 4 and 5). The condition is apparently one of thoracic stomach of the long esophagus type. Upon administration of an opaque meal, the stomach is seen to be filling in a water-trap fashion, is completely inverted, the cardia being just above the level of the diaphragm, the lower pole occupying the highest position in the chest. The pylorus and first portion of the duodenum lie mesial and behind the cardia, crossing it on entering the abdominal cavity (Figs. 6, 7 and 8). Further study reveals that part of the colon is also in the thoracic cavity. It required two large films to take a roentgenogram of a barium enema, as the colon extends from the right iliac fossa to the left clavicle (Figs. 9 and 10). There was no disturbance in motility of the stomach or intestine noted. The left diaphragm could at no time be definitely visualized and is either entirely absent or deficient to such an extent as not to be demonstrable.

The patient had no trouble until January, 1929, when another severe attack occurred. He was readily relieved after evacuation of the stomach was accomplished by change of pos-



FIG. 7. Stomach full. Oblique view. Duodenal bulb above cardia. Stomach completely inverted.

ture. Last attack occurred in August, 1931, and also required medical attention.

The patient always found it necessary to



FIG. 8. Stomach full. Posteroanterior position.

sleep on his left side and he awakes whenever he happens to turn on his right side. During the attacks he feels worse in the sitting position.

COMMENT

There is nothing in the history of the case to suggest that the condition is due to trauma as was first supposed. The only severe injury sustained (shrapnel wound)



FIG. 9. Five hours p.c. Small residue in stomach. Splenic flexure of colon above and lateral to stomach. Cecum in right iliac fossa.

was when the patient lay flat on his abdomen and was hit from above. It takes a great deal of force to rupture the diaphragm and it usually occurs when a severe blow is dealt on the abdomen or when the abdomen is strongly compressed, neither of these conditions having occurred. In this instance there were no symptoms at the time indicating respiratory or circulatory embarrassment, as would be the case with sudden extensive herniation of the abdominal viscera into the thorax. On the other hand, the patient definitely states that from childhood he was unable to climb mountains or engage in other

activities which would call for prolonged strenuous effort. He had no difficulty, however, in his adult life and stood the vicissitudes of the army regimen and imprisonment without any trouble. The service at the front, in the Carpathian mountains, called for considerable effort, as the soldiers were poorly fed and clothed, wore torn shoes when the snow was deep and suffered from cold and exposure. It has not affected his health in the least and he does not recall any illness whatever. We are evidently dealing with an anomalous condition to which he has gradually become adapted. The circulatory and pulmonary reserve which was apparently limited in childhood gradually increased and became quite adequate as he reached adult age. We must conclude, therefore, that we are dealing with a congenital condition.

NATURE OF THE ATTACKS

Judging from the description supplied by the patient and the attending physician, the attacks were probably caused by acute recurring volvulus of the stomach which untwisted itself under the relaxing influence of a narcotic or by change in the position of the patient. One can readily visualize how the stomach, in its inverted position when overloaded, may sag and, by its own weight, close off both the cardiac and pyloric orifices, producing real torsion of the organ. Most of the cases of volvulus or torsion of the stomach have been reported by surgeons, often as an accidental finding in operating for acute abdomen with no definite diagnosis.^{1,2,8,14,22,27} Before the era of roentgenography, few cases were diagnosed preoperatively and some only on the autopsy table. However, not all cases come to surgery as recurrent volvulus with spontaneous reduction, though very rare, has been reported in the literature.^{6,15,30} Payer²² could find only 22 cases of volvulus of the stomach reported in the literature from 1866, when the first case was described by Berti, until 1909. Kocher and Richter¹⁴ in 1914 reported 28 cases. For a complete bibliography and a thor-

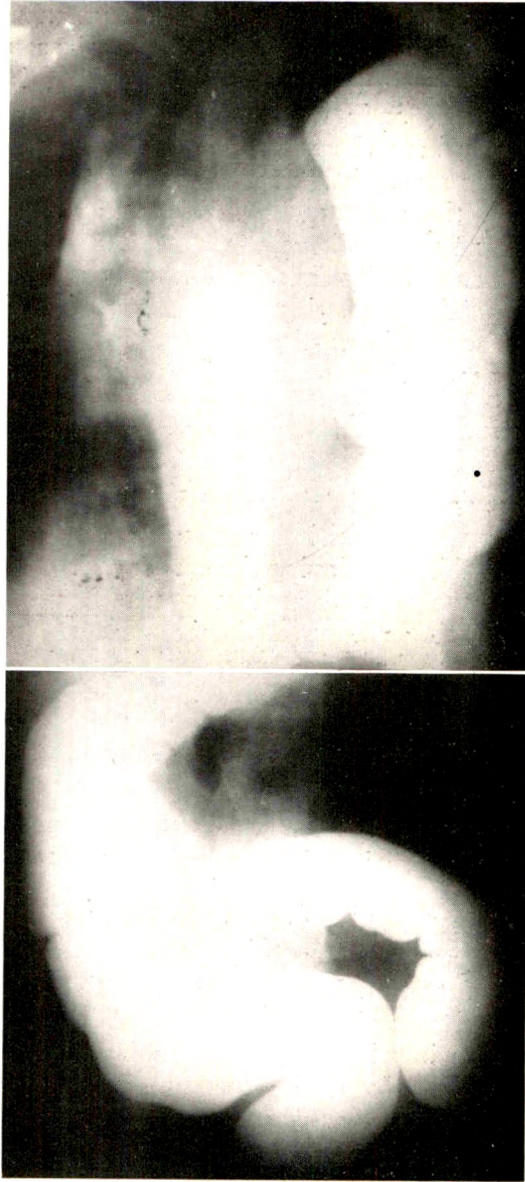


FIG. 10. Barium enema. Splenic flexure almost reaches the level of the clavicle.

ough discussion of the subject, the reader is referred to the excellent article by Sutter,²⁷ who analyzed the 58 cases found in the literature up to 1929. Sutter, however, excluded all cases which were due to diaphragmatic hernia. In discussing the etiology of volvulus of the stomach, Payer, who frequently is quoted on this subject, mentions diaphragmatic hernia as one of the main predisposing causes. Another

factor responsible for the production of volvulus of the stomach, which may be considered in our case, is displacement by other abdominal organs (colon), particularly where the cardiac and pyloric ends of the stomach are made to approximate.

In the case reported here, the pylorus crosses the cardiac end of the stomach and one can readily conceive how an overfilled stomach in sagging may close off both orifices. It is worthy of mention that the patient, being aware of his condition, now tries to shorten the attacks by changes in posture, at times with fairly good results. As the attacks occur at infrequent intervals (four attacks in six years) he has not had many opportunities at experimenting with himself in developing the proper technique. He was warned against overloading the stomach as a prophylactic measure and seems to be quite successful in avoiding serious trouble for long periods of time.

DIFFERENTIAL DIAGNOSIS

This is not the first case in which the presence of the stomach in the thorax was mistaken for hydropneumothorax. References to this common error in diagnosis will be found in many reports dealing with diaphragmatic hernia, eventration or thoracic stomach. Attempts at aspiration were not always unsuccessful. Truesdale²⁹ cites a case in which milk was aspirated from the chest by exploratory puncture. Carman and Fineman⁴ quote Downes as asserting that there are cases on record of death resulting from paracentesis thoracis because of mistaken diagnosis. Sailer and Rhein²⁴ report two exploratory punctures in a case of eventration with negative results. Struppler's²⁶ case had nineteen exploratory punctures of the chest with negative results before the correct diagnosis was made. Lebon¹⁸ reported two cases of false pneumothorax, one in a soldier who had the stomach punctured twice by paracentesis thoracis.

Probably, if the paracentesis in my case had been done after a meal, it would not have resulted in a dry tap. Another pos-

sibility is that the colon, in its position between the stomach and chest wall, prevented successful aspiration. Cunningham and Shaw,⁵ reporting a case very similar to mine, speak of this very common mistake, which really should not be made, if sufficient thought and care are given in arriving at a diagnosis. Harris and Stivelman⁹ at first mistook a case of eventration of the right side of the diaphragm for hydropneumothorax but after careful deliberation and roentgenographic study with the administration of a barium meal, arrived at the correct diagnosis. Harris and Clayton-Greene¹⁰ changed their diagnosis of pneumothorax to diaphragmatic hernia on clinical evidence. Likewise, Stivelman,²⁵ doubting the correctness of the diagnosis of pneumothorax in a tuberculous patient, administered a barium meal and found the case to be one of eventration. The opaque meal and roentgenoscopy always settle the question and should never be omitted, although a careful analysis of the history and physical findings should make one doubtful whether the case is really one of hydropneumothorax. This is especially true in those instances where the general appearance and condition of the patient seem too good to suspect a hydropneumothorax, which is a rather serious pathologic intrathoracic complication.

The differentiation between thoracic stomach, absence of diaphragm, eventration and hernia is often difficult and at times impossible. The diaphragm in eventration is sometimes so thin that it cannot be distinguished from the fundus of the stomach except at its attachments. Nor can one always be certain that the left diaphragm is absent when it is not demonstrable roentgenologically. As a rule, the recognition of the various conditions is simple as the characteristic points are quite definite and clear-cut, but some cases present features favoring one diagnosis, other evidence pointing to another. Korn's,¹⁷ in a critical review of the literature and discussion of the cases reported, points out many errors in diagnosis, when eventration

is called hernia, and vice versa. Meyers²¹ seems to be entirely confused on the terminology. He reports a case as hernia of the diaphragm in which he was unable to see the diaphragm and makes a final diagnosis of diaphragmatic eventration.

Thoracic stomach is not always reported as such. LeWald calls attention to the case of Fineman and Connor⁷ which was reported as diaphragmatic hernia, while it really should be considered a thoracic stomach. Likewise, the cases of Bund,³ Plenk,²³ Huffman,¹¹ and Tonndorf,²⁸ cited by Fineman and Connor, according to the description of the authors, should be considered as true cases of thoracic stomach, as in all of them practically the entire stomach, including the cardia, was above the diaphragm, yet they were reported as herniae. Koppenstein,¹⁶ in a comparatively recent article, describes a case of thoracic stomach and names it so in English, but calls it a herniated stomach as the German equivalent. This probably accounts for the fact that Jenkinson,¹³ in reporting his case of thoracic stomach, failed to include these cases among those he mentions as previously reported.

In the case described above, where the diaphragm could not be outlined even at the periphery, and where the lung tissue could be made out through the gas bubble, one has to consider it as one of absent left diaphragm, associated with a thoracic stomach, inasmuch as the cardia is above the level of the diaphragm. However, it is possible that the diaphragm is defective to such an extent as not to be demonstrable. With the entire stomach and a large portion of the colon in the chest cavity, the defect in the diaphragm, if there is one, must be enormous, constituting really a partial or complete absence of the diaphragm. The comparative freedom from symptoms up to the age of thirty-three, and then over a long period of time,

also suggests the presence of a large opening in the diaphragm, or the absence of same altogether, allowing of free movements of the stomach and splenic flexure of the colon without strangulation. This is not incompatible with long life and even with freedom from symptoms. LeWald reported the case of a man, thirty-four years of age, with complete absence of left diaphragm, who has won athletic honors in long distance running contests, and of a woman, aged sixty-three, with no evidence of a diaphragm on the left side and the abdominal organs in direct contact with the pleura and pericardium. Jenkinson, besides his own, collected 11 more cases from literature. Incidentally, the case of Harris and Clayton-Greene was also at first mistaken for pneumothorax.

SUMMARY

1. A case is reported of inverted thoracic stomach of the long esophagus type with periodic attacks suggesting acute volvulus or torsion of the stomach and associated with partial or complete absence of the left diaphragm.

2. The differentiation between thoracic stomach, absence of, eventration and herniation of the diaphragm usually presents no difficulty, but at times the exact diagnosis is impossible or almost so. The administration of a barium meal and roentgenologic examination simplifies the problem.

3. Attention is called to the frequency with which the conditions are mistaken for hydropneumothorax in spite of repeated references in the literature to the possibility of such an error and comparative ease of differentiation by means of a barium meal. More general recourse to the roentgenologic visualization of the stomach and colon with administration of an opaque meal would obviate such errors, especially when paracentesis thoracis is contemplated.

REFERENCES

1. BERTI. Quoted by Sutter, ref. 27.
2. Boysen, I. Beitrag zur Kenntnis des partiellen Magenvolvulus bei einem Zwerchfelldefekt, kompliziert durch ein blutendes Magengeschwür. *Arch. f. klin. Chir.*, 1921, 117, 768-783.
3. BUND, B. Ein Fall von rechtsseitiger Hernia diaphragmatica mit Austritt des Magens in den persistierenden Rezessus pneumatoentericus dexter. *Frankfurt. Ztschr. f. Path.*, 1918, 21, 243-257.
4. CARMAN, R. D., and FINEMAN, S. The roentgenologic diagnosis of diaphragmatic hernia. *Radiology*, 1924, 3, 26-45.
5. CUNNINGHAM, L. W., and SHAW, W. McL. Eventration and hernia of the diaphragm. *J. Florida M. Ass.*, 1924-1925, 11, 7-19.
6. EVANS, J. Hernia of the diaphragm, with report of case of the congenital variety complicated by periodic rotation of the stomach. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1927, 18, 133-136.
7. FINEMAN, S., and CONNOR, H. M. Right diaphragmatic hernia of the short esophagus type. *Am. J. M. Sc.*, 1924, 167, 672-679.
8. HABERER, H. Teilweiser Magenvolvulus bei Verlagerung des Magens durch eine Zwerchfellücke. *Deutsche Ztschr. f. Chir.*, 1926, 195, 80-89.
9. HARRIS, L. I., and STIVELMAN, B. P. Nonrotation of stomach simulating spontaneous hydropneumothorax. *J. Am. M. Ass.*, 1927, 89, 1836-1837.
10. HARRIS, W., and CLAYTON-GREENE, W. Congenital absence of the left half of the diaphragm, simulating pneumothorax. *Proc. Roy. Soc. Med.*, 1911-1912, (Clin. Sect.), 5, 153-156.
11. HUFFMAN, L. F. Case of diaphragmatic hernia observed post-mortem. *Ann. Surg.*, 1920, 72, 665.
12. HUME, J. B. Congenital diaphragmatic hernia. *Brit. J. Surg.*, 1922, 10, 207-215.
13. JENKINSON, E. L. Absence of half of the diaphragm (thoracic stomach; diaphragmatic hernia). *Am. J. ROENTGENOL. & RAD. THERAPY*, 1931, 26, 899-903.
14. KOCHER and RICHTER. Quoted by Sutter, ref. 27.
15. KÖHN, H. Chronischer Magenvolvulus. *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1929, 41, 220-227.
16. KOPPENSTEIN, E. In den Brustkorb herniierter Magen (thoracic stomach). *Röntgenpraxis*, 1930, 2, 31-35.
17. KORN, H. M. The diagnosis of "eventration" of diaphragm. *Arch. Int. Med.*, 1921, 28, 192.
18. LEBON, H. Les faux pneumothorax in radiologie. *Presse méd.*, 1919, 27, 351.
19. LEWALD, L. T. Thoracic stomach; differentiation from eventration and hernia of the diaphragm. *Radiology*, 1924, 3, 91-104.
20. LEWALD, L. T. Roentgenological diagnosis of diaphragmatic hernia. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1928, 20, 423-430.
21. MEYERS, G. B. Complete unilateral diaphragmatic hernia. *Pennsylvania M. J.*, 1930, 33, 390-391.
22. PAYER, A. Volvulus ventriculi und die Achsendrehung des Magens. *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1909, 20, 686-726.
23. PLENK, A. Zur Kasuistik der Zwerchfellhernie. *Wien. klin. Wchnschr.*, 1922, 35, 339-341.
24. SAILER, JOSEPH, and RHEIN, R. D. Eventration of the diaphragm, with a report of a case. *Am. J. M. Sc.*, 1905, 129, 688-705.
25. STIVELMAN, B. P. False pneumothorax. *J. Am. M. Ass.*, 1920, 74, 12.
26. STRUPPLER, TH. Ueber den physikalischen Befund und die neueren klinischen Hilfsmittel bei der Diagnose Zwerchfellshernie. *Deutsche Arch. f. klin. Med.*, 1901, 70, 1-16.
27. SUTTER, K. Zur Diagnose und Behandlung des partiellen Magenvolvulus. *Deutsche Ztschr. f. Chir.*, 1929, 213, 341-390.
28. TONNDORF, W. Wahre Zwerchfellhernien als Folge einer Wachstumshemmung der Speiseröhre. *Deutsche Ztschr. f. Chir.*, 1923, 179, 259-265.
29. TRUESDALE, P. E. Diaphragmatic hernia. *J. Am. M. Ass.*, 1921, 77, 993-998.
30. VON FRIEDRICH, L. Ein Fall von chronischem Magenvolvulus. *Deutsche Ztschr. f. Chir.*, 1926, 198, 185-189.



AUDITORY EFFECTS OF ROENTGEN RAYS IN DOGS*

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INTRODUCTION

AS A preliminary investigation of the effects of roentgen rays upon auditory acuity in dogs, two animals were exposed to a variety of doses over a period of months.

Investigation upon the biological effects of roentgen rays ranges from studies on the single cell to studies on a complete human system. Perhaps least is known in regard to their effects upon sensory processes. For example, numerous reports in the literature are concerned with the effects of roentgen rays upon deafness; but in no case, for clinical reasons, have the studies dealt with their effects upon normal hearing. Inasmuch as deafness results from different pathological conditions it is not surprising that the results reported are inconsistent. An additional handicap is the inadequacy of present methods of testing hearing, as compared with the more standardized and accurate visual tests.¹ The results, therefore, have been contradictory: some studies reported beneficial effects with the use of roentgen rays in the treatment of impaired hearing,² while others have reported negatively.³

But if clinical data are meager and inconclusive, experimental data are totally lacking. Desjardins⁴ has summarized rather

thoroughly the experimental studies concerned with the effects of radium and roentgen rays upon the eye and ear. The number of studies concerned with the eye far outnumber those relating to the ear—202 titles against 50 titles—and none of these studies is concerned with the effects of roentgen rays on hearing as such. For therapeutic as well as for theoretical significance, an experimental technique for just this type of investigation—the study of the sense modality *per se*—appears to be of some importance. From a psychological point of view, the “conditioned response” technique suggests itself immediately, both for complete control of experimental conditions and for accurate measurement of auditory acuity.

The dog is used as the experimental animal for several reasons: adaptability to the conditioned response technique, relative ease in training and testing, domesticity, and possession of an auditory mechanism similar to that of man.

TECHNIQUE AND APPARATUS

The animal undergoes a preliminary training of about three weeks, during which time it is “conditioned” to respond to a given tone. The dog has a fixed position in a rack, with the right fore paw resting upon a metal grill through which a mild electric shock is administered (Fig. 1). The tone, a 1000 cycle sound, is presented for a three second period and followed immediately by a mild shock through the grill, just strong enough to effect a reflexive withdrawal of the dog’s paw. The animal in this way learns to lift his paw as soon as the sound begins, and is tested for about a half hour each day—the tone and shock being given for 25 trials. Both the shock and sound are electrically controlled, the sound being presented at irregular inter-

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¹ Richardson, J. J. X-Rays as an advance in the treatment of hearing. *J. M. Ass. Georgia*, 1924, 13, 161–165. He states that the “best single test (of hearing) is the distance measure of the spoken and whispered voice . . . while difficult to standardize, yet (a) skilled otologist can control his voice to determine whether hearing of subject has materially improved.” P. 162 ff.

² *Ibid.* He used a 4” spark gap and 8 ma., and reports that “It was soon found that radiation could be directed practically anywhere on the head . . . with betterment of hearing clinically.” P. 164.

³ Desjardins, A. U. Action of roentgen rays and radium on the eye and ear. *Am. J. Roentgenol. & Rad. Therapy*, 1931, 26, 634; 787; 919.

⁴ *Op. cit.* This is perhaps the best summary of clinical as well as experimental data.

vals to prevent temporal conditioning. The dog is observed throughout the entire test through a window which is so constructed as to prevent the animal seeing the experimenter or getting any "cues" from his movements.

By the end of three weeks the animal is usually thoroughly trained, and ready for threshold (limen) determinations. The usual psycho-physical procedure is followed, in that the sound is progressively weakened, on each trial, from supra- to sub-liminal intensity and vice versa. In all, four series of readings are taken—twice from strong to weak and twice from weak to strong intensities—alternately presented. The intensity of the sound is controlled by means of an attenuator⁵ which is a series of resistances so arranged as to increase or decrease the sound intensity in decibel steps. The decibel is used as the sensation unit in describing the magnitude of sounds; a change in power level of a sound by one decibel is approximately the smallest that the human ear can detect.⁶

⁵ For a good description see Witting, E. G. Apparatus used in recent Baltimore experiments on the physiology of the ear. *Laryngoscope*, 1932, 42, 497-505.

⁶ Fletcher, H. Speech and Hearing, 1929, p. 68 ff.

A sound of some convenient intensity is taken as the standard, and is then reduced in four decibel steps. The stimuli are given usually at from three to five levels (rarely more or less) in order to procure 100 per cent response at the strongest sound level, and 0 per cent (no) response at the weakest sound level. Thus during any test, 12 to 20 readings are taken at the different intensity levels.

The limen, in absolute threshold determinations, is taken at the 50 per cent point—the point at which the probability of response is one-half—and is determined from the percentage of responses at the different levels by some form of the "method of least squares."⁷ The readings are taken for a number of days until the animal's performance is quite consistent. The dog is then irradiated, and the effects are studied by subsequent testing.

The significance of any change in acuity over a period of time is determined in the

⁷ Brown, W., and Thomson, G. H. The Essentials of Mental Measurement, 1925, p. 44 f. The 50 per cent point may be determined by a variety of methods (such as straight linear interpolation, the Spearman Mean Method, and the so-called Phi Gamma Function); and the limens, as determined by the different methods, do not appreciably differ.

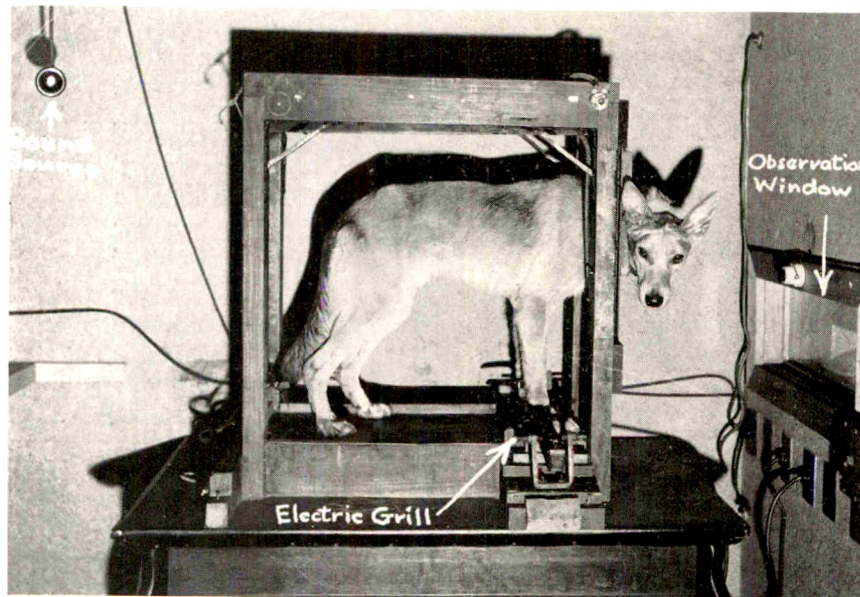


FIG. 1. Testing apparatus. A recent picture of Dog No. 1. Loss of hair is quite evident.

usual statistical manner.⁸ The readings before and after irradiating are conveniently grouped, and the means and standard deviations calculated. The standard error of the mean is obtained by dividing the standard deviation of the distribution (group) by the square root of the number of cases involved (which in this case is 10). The differences between the means are tabulated, and their standard errors determined—from which data, “*t*,” the ratio of the actual difference (between two means) to its standard error, is calculated. By use of the proper tables⁹ the significance of any “*t*” (for a given number of cases) is directly given in terms of *P* (probability value).

⁸ Fisher, R. A. *Statistical Methods for Research Workers* 1925, chap. 5. Also reference given below.

⁹ Fisher, R. A. Application of “Student’s” Distribution, *Metron* 1925, 5, 90–120. While Pearson’s tables are in more common use, Fisher’s are made particularly for small samples of data.

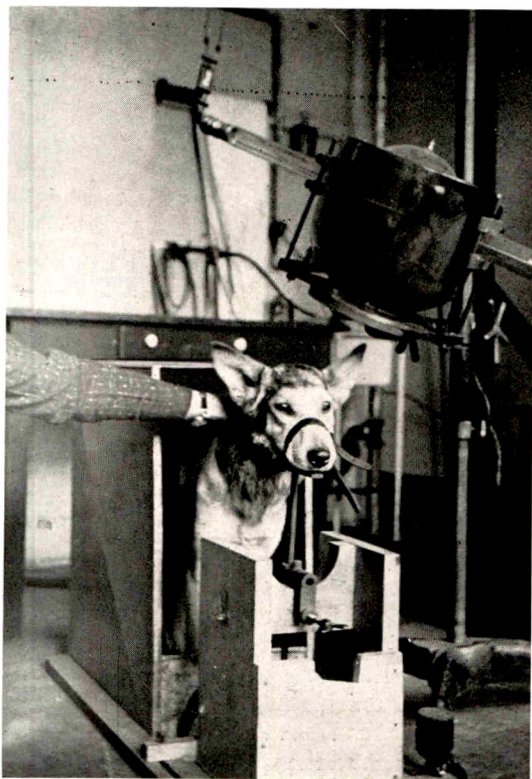


FIG. 2. Roentgen apparatus. 200 kv. Coolidge tube, “universal” type. The lead covers to limit area of exposure are not shown. (Dog No. 1 a year ago; hair still present.)

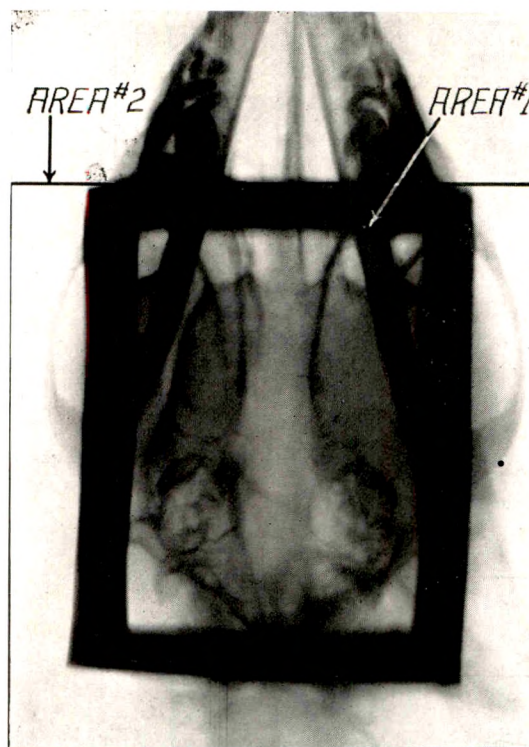


FIG. 3. Area #1: 6×8 cm., area first exposed in Dog No. 1. Area #2: 13×13 cm., area exposed in Dog No. 2.

As an example, suppose we wish to determine the significance of the first rise in acuity in Dog No. 2. In this case let us compare the two means before the rise occurs (Fig. 4) with the two immediately following. The four means with their standard errors are: 47.7 ± 1.5 , 48.4 ± 0.89 , 54.9 ± 0.99 , and 55.2 ± 1.2 . (The standard deviations of the four distributions respectively are: ± 4.7 , ± 2.8 , ± 3.1 and ± 3.6 , and the standard errors were calculated by dividing each of the standard deviations by the square root of 10). Subtracting the first two means from each of the second pair gives the actual decibel differences: 7.2, 7.5, 6.5, and 6.8. The standard error (deviation) of each difference is the square root of the sum of the squares of the standard errors of the two means. In the case of the first and third means (47.7 and 54.9) the standard error of their difference equals the square root of $[(1.5)^2 + (0.99)^2]$ which is 1.8, and “*t*”—

the actual difference divided by its standard error (7.2 divided by 1.8)—is 4.0. Referring to Fisher's tables¹⁰ "t" is given directly in terms of P, which in this case is 0.0004. Repeating this procedure for the other differences, the following table is derived:

1st Mean 47.7	$\frac{7.2}{1.8}$ t = 4.0 P = 0.0004	$\frac{7.5}{1.9}$ t = 3.9 P = 0.0005
2nd Mean 48.4	$\frac{6.5}{1.4}$ t = 4.6 P = 0.0001	$\frac{6.8}{1.5}$ t = 4.5 P = 0.0001
	3rd Mean 54.9	4th Mean 55.2

When the value of P is less than 0.02 (that is, when a difference of this magnitude would occur as a result of purely random sampling less than 2 times in a 100) the difference is considered valid, and not due to "chance." In this example all the values of P are much smaller than 0.02, and the differences therefore quite significant.

By use of a continuous radiator Coolidge therapy tube* (mechanically rectified—rating 200 kv., 6 ma.), doses of more than five minutes were possible. The areas of radiation were carefully controlled by reference to anatomical structures in the head (such as the lambdoidal ridge) and the surrounding areas covered with lead. The animal was held securely in place by a metal container—also lead covered during irradiations—giving accurate control of the exposed area (Fig. 2).

EXPERIMENTAL CONDITIONS

Most irradiations were given at 85 kv.

¹⁰ *Ibid.*, *Metron*, pp. 114-120.

* The authors wish to express their indebtedness to Professor G. L. Clark for making available the facilities of the X-Ray division of the University of Illinois, and to Dr. K. E. Corrigan, for his kind assistance and suggestions in the irradiation of the animals.

and 5 ma., with the exception of a few early doses to Dog No. 1 at 50 kv. Variation in line voltage resulted in a variation of ± 3 kv. (as checked by sphere gap). The target distance for the most part was 25 cm. ± 0.5 . The roentgens as determined by the Victoreen r meter (calibrated in international units) at these values was 2.5/second. At a distance of 30 cm. with an aluminum filter interposed, the r dropped to 1.5/second. No account was taken of surface intensity (back-scattering) for all calculations were determined by direct radiation of the ionization chamber.

Dog No. 1. The first irradiations were aimed directly at the top of the head, including the area from above the eyes back to the lambdoidal ridge—distance 8 cm. and 3 cm. on each side of the median line (Fig. 3). Some doses were given at 50 kv., but upon discovering the fact that, at this voltage and 5 ma. only 0.025 r/second was being generated, the old value—85 kv.—was returned to. Irradiation started November 23, 1931, and was continued until March 11, 1932, with a total dosage of 4,500 r. The area of radiation was then changed to direct exposure of the ears at a distance of 30 cm., kilovoltage and milliamperage remaining the same. This period continued until April 6 (total r = 3,350) when the animal began to be sensitive on top of the head. The beam was then filtered through 0.5 aluminum until April 16, during which time 3,250 more r accumulated. The irradiation then had to be halted because of skin burns. Originally, some silver nitrate was used in marking the dog's head, which may have had something to do with the loss of hair in this animal. The total dosage for this animal was over 11,100 r.

Dog No. 2. In this animal 85 kv., 5 ma., and a target distance of 25 cm. was used for all irradiations. Comparatively larger doses were used, beginning with an exposure to 75 r, and concluding with four 1000 r doses. A somewhat larger area was irradiated: the entire width of the skull (13 cm.) and from above the eyes caudally 13 cm. to the spinal cord (Fig. 3). The first dose was given January 23, 1932, and the last one June 10. The total cumulation was over 4,400 r. No silver nitrate was used on this dog, but in March it, too, showed signs of "baldness."

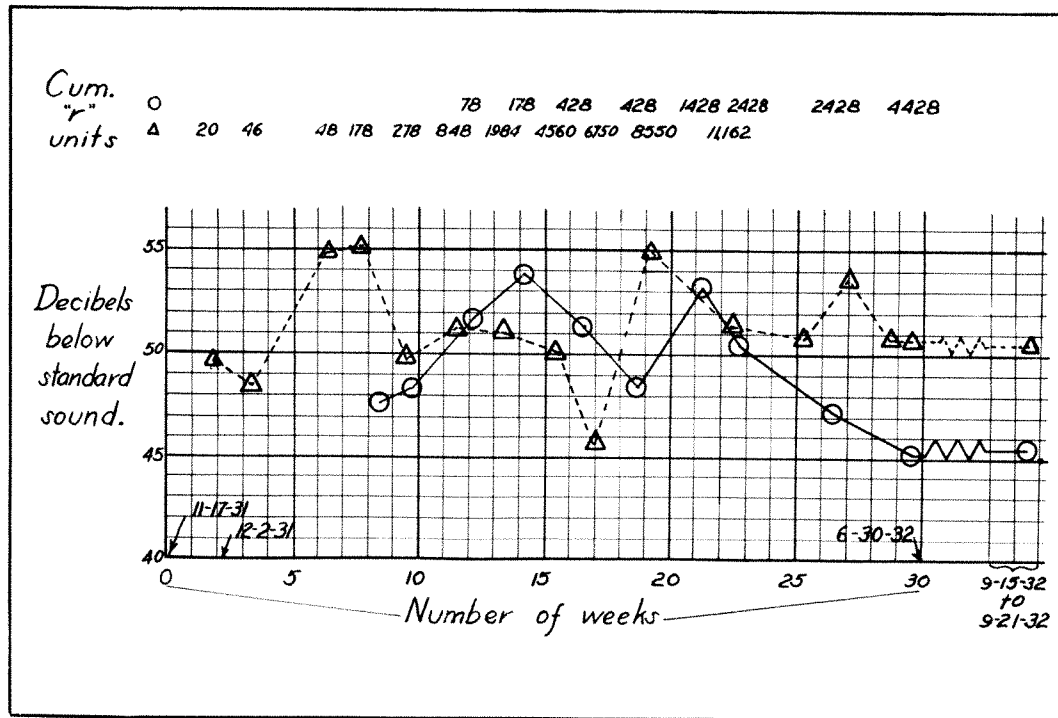


FIG. 4. 1. Dog No. 1 indicated by \triangle --- \triangle and Dog No. 2 indicated by \circ — \circ 2. Each \triangle and \circ represents a mean of 10 consecutive tests except in the last case (September, 1932); for \triangle it is an average of 6, and for \circ it is an average of 11 cases. 3. Dog No. 1 started November 17, 1932, and Dog No. 2 December 2, 1932, as indicated.

RESULTS

In both cases there is a transient *increase in auditory acuity* lasting some four weeks, followed by a relapse to normal. The animals were under continued exposure to roentgen rays, so that there are no accurate data on the true duration of this increase in acuity in these animals.¹ The acuity of Dog No. 2 dropped 2 decibels for the last twenty-odd tests, taken through June and September. This may be accounted for by the continued presence of skin burns, and the concomitant difficulty in testing the animal. The acuity of Dog No. 1 never stayed significantly low, though at one time (March: about the 17th

¹ Further data on different animals have been gathered with respect to this initial rise in acuity, and are at present being checked by use of control groups of animals: that is, irradiating one animal and not the other.

Examination of the graph will show a second rise in acuity in both dogs. This is much more transient than the first; in Dog No. 1 it lasted for about 10 days, and in Dog No. 2 lasted about 15 days. As yet, no further work has been completed on new animals under comparable conditions.

week on the graph) the readings showed a downward trend, which after a while returned to the normal level.

Both animals showed apparent manifestations of "nervousness," both in their general behavior as well as during test periods. Up until last December (at which time Dog No. 2 was despatched during another experiment) both animals appeared to be quite "normal," the single incongruity being the lack of hair on top of their heads. Dog No. 1 at present is, however, quite emaciated and the blood in poor condition. The normal blood count of this animal last year was: red blood cells 5,500,000 and white blood cells (leucocytes) 12,000—which is within the limits of normal variability in dogs. Recent examination showed the red blood count to be about 3,500,000, and the white blood count to be 6,500, both much below normal. Recent tests indicate that this animal's hearing is still normal.

At 85 kv. and 5 ma., 1,200 r seems to be the maximum dose that can be given in a two week period without subsequent development of skin burns. Although the total cumulated dose in Dog No. 2 was much less than that of Dog No. 1 (4,500 to 11,100) the skin burns showed up sooner in Dog No. 2. The explanation is possibly two-fold: in the first place, the area of exposure in Dog No. 2 was larger (169 sq. cm. to 69 sq. cm. for Dog No. 1¹²) and secondly, the last two doses for Dog No. 2—1000 r each—were but nine days apart. The skin burns in the latter began to appear a week after the second of these two doses. Dog No. 2, up until the time of his death in December, never recovered from the skin burns, whereas Dog No. 1 at present shows no signs of them at all. Most of the burns in the latter animal disappeared as early as last September. There is, too, some indication of the hair reappearing in this animal.

¹² Kaplan, I. I. *Practical Radiation Therapy*, 1931, p. 91: "... there may ... be as high as 30% increase in surface intensity by changing the field from 5×5 to 20×20 cm."

SUMMARY

The conditioned response technique is suggested as a means of direct study of the effects of roentgen rays upon hearing in dogs. By means of this approach accurate investigation of the effects of roentgen rays upon hearing itself is permitted. In the animals reported on, as well as in subsequent studies nearing completion, an initial rise in auditory acuity results from exposure to small doses of roentgen rays generated at 85 kv. and 5 ma. This increase in acuity is a transient effect lasting from two to four weeks.

Cumulated doses up to 11,100 r in one animal and over 4,400 in another resulted in neither a fatality nor impaired hearing. The skin burns were due to overexposure to soft rays. Spacing of the larger doses over longer periods of time avoids this hazard.

The investigation is being widened to include the study of the effects at higher voltages, and also, by means of the oscillograph technique, the direct effect on the nervous mechanism involved in audition.



EFFECTIVE APPLIED VOLTAGE AS AN INDICATOR OF THE ENERGY EMITTED BY A ROENTGEN-RAY TUBE*

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ABSTRACT

A previous study¹ suggested a parallelism between the applied effective voltage and the emission of a roentgen-ray tube. The investigation has been carried further under more carefully controlled conditions. It is found for two mechanical rectifiers and one "constant potential" generator that the roentgen-ray emission per *effective (root-mean-square) milliamper*e of tube current is about the same for all generators operating at the same *effective (r.m.s.) voltage* (the radiation passing through the same filter in all cases). Thus it becomes possible to express all radiations in terms of that excited by constant potential. This leads to a simplification in the description and reproduction of irradiation conditions in biological work. Although the study has been limited to three generators, it is believed that they are sufficiently typical of other types to warrant generalization.

I. INTRODUCTION

IN A recent study the energy emitted by a roentgen-ray tube, as measured by an ionization chamber, was found to be very different when excited by different types of high tension generators furnishing the same average tube current and *peak voltage* (as measured by a sphere gap). But it was further found that for the same average currents and the same *effective voltage** of the generators, the emission, as measured by the ionization chamber, is approximately the same.

The total energy in a roentgen-ray spectrum devoid of characteristic lines varies

as the square of the instantaneous applied voltage, and hence for a known voltage wave form the total energy and its wave length distribution, for the period of a complete cycle, is calculable. Because of the presence of tungsten line radiation above 70 kv., it is not yet practicable to predict the total roentgen-ray energy by integrating over one cycle of the voltage wave. In the present work the roentgen-ray emission per unit tube current, as it varies with peak voltage, with average voltage and with effective voltage per unit tube current, is given for more carefully controlled and wider ranges of conditions. This is expressed in terms of the roentgen-ray *emission per milliamper*e.

II. APPARATUS

Thus far three generators have been used, designated by *A*, *B* and *C* as in the preceding work.¹ *A* is a full wave mechanical rectifier having a single high tension transformer, and rectifying over approximately 30 degrees of cycle; *B* is also a full wave mechanical rectifier but with a divided high tension transformer, and rectifying over approximately 20 degrees of the cycle; *C* is a valve tube-condenser ripple potential* generator (so-called "constant potential") having a rippleage of about 2

* The term "constant potential" has been used loosely to describe the potential supplied by kenotron or other valve tube rectification. A more accurate designation of voltage which is not constant in fact but fluctuates slightly about a certain average value is "ripple voltage." Thus by a "ripple quantity" (potential or current) is meant a simple periodic quantity $y = V_0 + V_1 \sin(\omega x + \alpha_1) + V_2 \sin(2\omega x + \alpha_2) + \dots$ in which the constant term (V_0) is so large that all values of the quantity are positive (or negative). The amount of ripple ("rippleage" or "rippleance") in a ripple quantity is the ratio of the difference between the maximum and minimum values of the quantity to the average value.

These definitions are under consideration by the Committee on Electrical Definitions of the American Standards Association under the sponsorship of the A.I.E.E.

* Second part of paper presented at meeting of American Association for Advancement of Science and the American Roentgen Ray Society, Syracuse, N. Y., June, 1932.

¹ Taylor, L. S., and Tucker, K. L. *Bur. Standards J. Research*, 1932, 9, 333 (RP 475). Also: *Am. J. ROENTGENOL. & RAD. THERAPY*, June, 1933, 29, 826-843.

* Effective voltage is mathematically the same as root-mean-square (r.m.s.) voltage.

per cent per milliampere. The three generators could be interchangeably connected to the roentgen-ray tube.

1. Current Measurements

The arrangement of the apparatus is indicated in Figure 1. *Average* current

difficulty in peak voltage measurements with the sphere gap but this was largely eliminated by placing inductively wound surge resistors, r_2 , immediately next to the rectifier switches, giving smoother operation of the equipment and more consistent peak voltage measurements. After raising

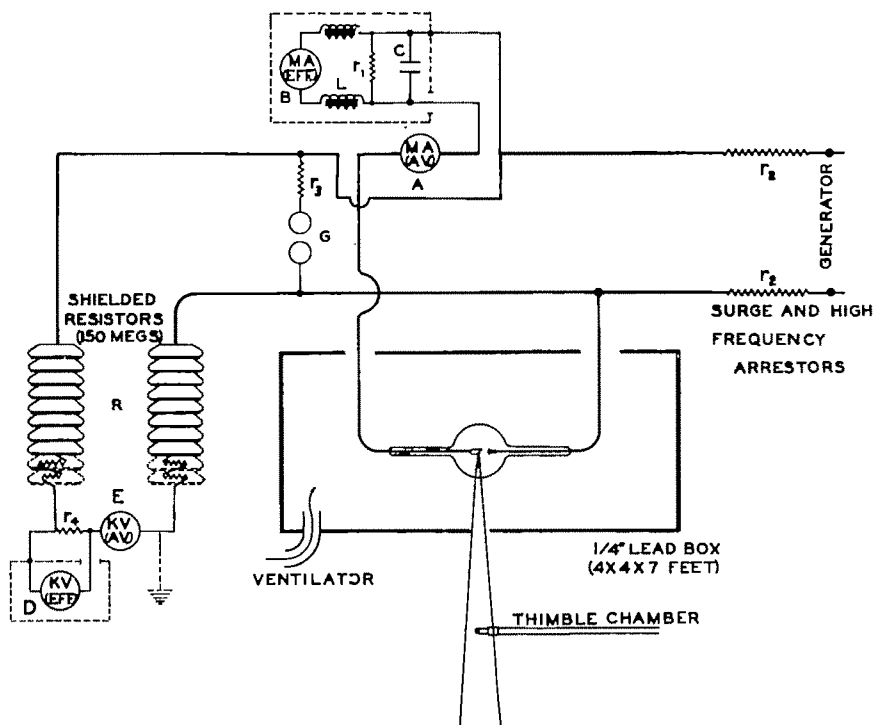


FIG. 1. Diagram of apparatus showing voltage and current measuring equipment.

through the tube is measured in the usual manner by a d.c. milliammeter *A*; and the *effective current* by an a.c. milliammeter, *B*. For this purpose, a thermo milliammeter alone was available. This was protected from high frequency oscillations by iron core chokes, *L*, having a d.c. resistance of a fraction of an ohm; a noninductive resistor, *T*, of about 10,000 ohms, and a $1/20 \mu\text{f}$ capacitor, *C*. Since the resistance of the meter, *B*, was only about 20 ohms, this shunt system served as a very effective filter against high frequency oscillations in the high tension system, without affecting the sensitivity.

Excessive high frequency oscillation when using the mechanical rectifiers caused

the generator voltage sufficiently to compensate for the potential drop across the resistors, it was found that their presence did not alter the tube output in any way.

With generator *C*, the same resistors were used for the purpose of limiting the current in case of slight tube gassiness or when using a sphere gap for measuring the voltage. It was found that they raised the voltage limit very materially at which a given tube would operate satisfactorily.

2. Voltage Measurements

Peak voltage of all three generators was measured by the gap between 12.5 cm. spheres, protected by a water resistance, r_1 , to prevent heavy arcing at the gap and

consequent tripping of circuit breakers.

Average voltage was measured by means of a d.c. microammeter, E , in a series with a shielded high voltage resistor of 150 megohms,² the meter being at the center of the resistance so as to be at or near ground potential.*

Effective voltage was measured by means of a 150-volt calibrated Kelvin multi-

3. Radiation Measurements

The roentgen-ray emission was measured by means of a thimble chamber kept in a fixed position with respect to the tube throughout the study. The beam was in all cases filtered by 0.525 mm. of copper, the wall effect of the chamber being negligible for the transmitted radiation.

No other determination of radiation

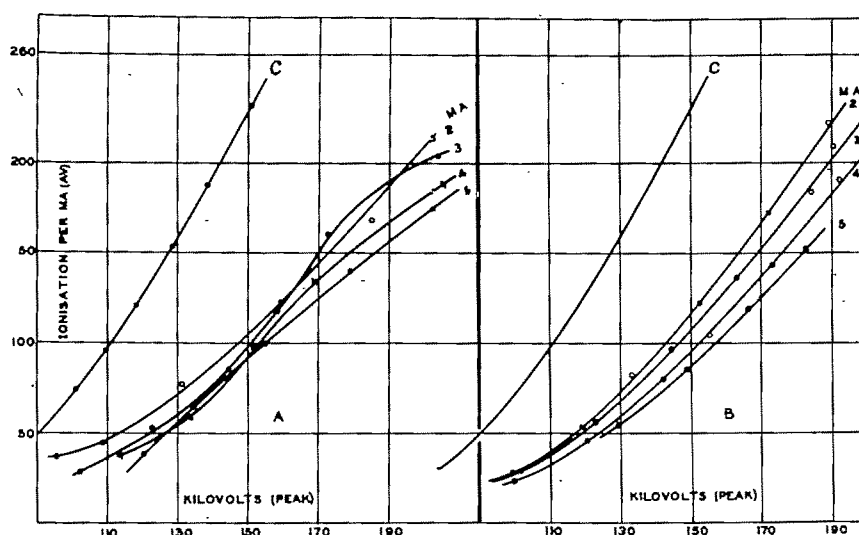


FIG. 2. Relationship between roentgen-ray tube emission, for average milliampere, and the applied peak voltage. A, B, mechanical rectifiers; C, constant potential.

cellular electrostatic voltmeter, D , shunted across a resistance, r_4 , of 75,000 ohms. Since its potential was likely to be different from ground, it was necessary to shield it by a metal case having the same potential as one of its terminals.

It should be stated here that the insertion of the high voltage resistor, R , across the line has no noticeable influence upon the operation of the high tension generators because the current it shunts off is very small. This fact is of course essential since a wave form very different from that under normal operating conditions may otherwise result.

*Taylor, L. S. *Bur. Standards J. Research*, 1930, 5, 609 (RP, 217).

* The voltage on the high tension conductors is seldom divided equally above and below ground potential, although the error in measurement introduced by grounding the resistor at the center is very small.

quality was undertaken, as the previous study¹ indicated what was to be expected under the operating conditions employed here, namely, all beams having the same effective voltage and filtration and giving equal intensities have approximately the same quality (whether expressed in the half-value layer of copper, copper absorption coefficient or effective wave length).

III. EXPERIMENTAL RESULTS

In this study, to eliminate the effect of variation in operation, simultaneous values were obtained for (1) average current, (2) effective current, (3) peak voltage, (4) average voltage, (5) effective voltage and (6) roentgen-ray tube output for a constant filtration of 0.525 mm. of copper, the average current (the quantity measured in practice) serving as independent variable.

In Figure 2, groups *A* and *B* show the tube emission, expressed in terms of the ionization current per average milliampere ($I/\text{ma. (av.)}$), as a function of peak voltage for generators *A* and *B*, respectively, and for different tube currents, 2, 3, 4, 5 ma. With generator *B* it is seen that for a given peak voltage, the value of $I/\text{ma. (av.)}$ varies from 10–15 per cent in changing the

hand and that of generators *A* and *B* (curves *A* and *B*) on the other. To obtain the same roentgen-ray emission from generators *A* and *B* as from generator *C*, the peak voltage of *A* and *B* must be very much larger than that of *C*, depending upon the operating current.

If, for the same radiations plotted in Figure 2, we plot instead the ionization per

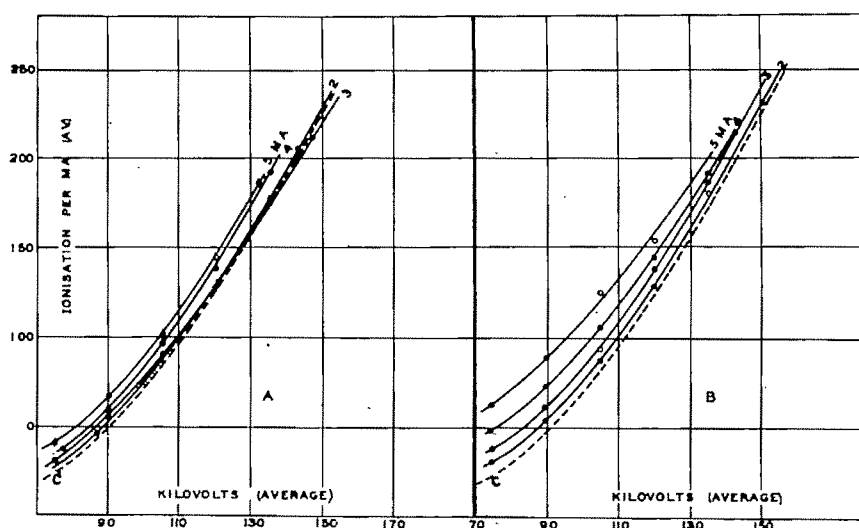


FIG. 3. Relationship between roentgen-ray tube emission, per average milliampere, and the applied average voltage. *A*, *B*, mechanical rectifiers; *C*, constant potential.

operating tube current by 1 ma. This is not unexpected since the generator wave form depends to a large extent upon the power drawn from the generator. It is obvious from these curves that it may be very misleading to attempt to deduce the emission of a roentgen ray tube from current and peak voltages alone. For generator *A*, $I/\text{ma. (av.)}$ varies erratically with peak voltage under different operating currents.

Figure 2, curve *C* in both groups is from generator *C* ("constant potential") for a tube current of 4 ma. Since the peak voltage of this generator does not vary appreciably with tube current (average voltage being kept constant), a single curve embodies the results. It is seen that for the same peak voltage there is a large difference between the roentgen-ray emission of generator *C* (curve *C*) on the one

average milliampere against the average voltage, corresponding curves, *A*, *B*, and *C*, in Figure 3 are obtained. It will be noted that $I/\text{ma. (av.)}$ again varies with the tube current. In the case of generator *A* the values of $I/\text{ma. (av.)}$ vary from about 2–8 per cent in changing the operating current by 1 ma. This percentage change becomes smaller, however, in going to higher average voltages, whereas, when the potential is measured in peak kilovolts, the changes become larger at higher voltages.

In the case of generator *B* the same general results obtain. The variation of $I/\text{ma. (av.)}$ with tube current at a given average voltage is, however, much greater at lower potential than for *A*, while at higher potentials it is about the same.

It is seen that, while the curves for *A* and *B* differ with tube current, they all lie in

the region of curve *C* (dashed) as contrasted with the corresponding curves of Figure 2 for peak voltages. Thus, if the current and voltage for all three generators be measured in terms of average milliamperes and average kilovolts (that is, by using d.c. instruments), the tube emission per milliampere is in all cases of the same order of magnitude.

is present but again to the least degree.

Of prime importance, however, is the fact that the curves (Fig. 4) for both generators *A* and *B* lie very closely along the curve for constant potential—much more closely at the higher voltages than those in Figure 3 for average current and voltage measurements. It is concluded that, for equal effective roentgen tube currents and

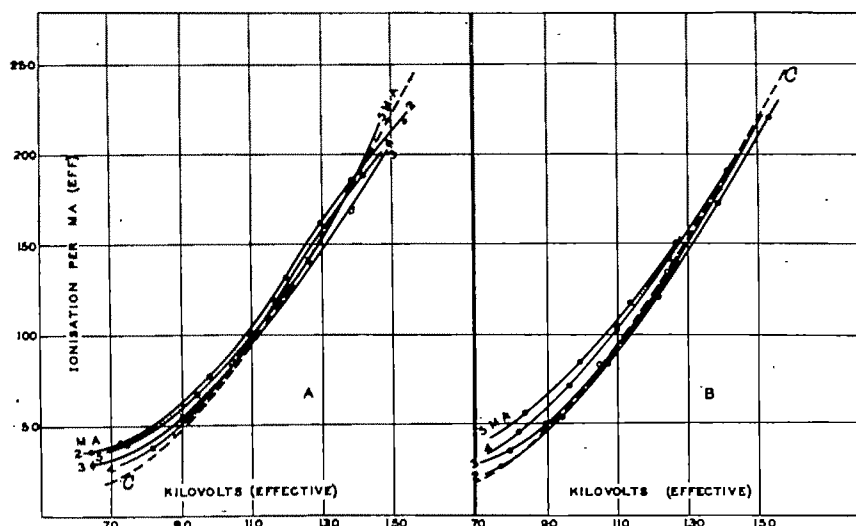


FIG. 4. Relationship between roentgen-ray tube emission, per effective milliampere, and the applied effective voltage. *A*, *B*, mechanical rectifiers; *C*, constant potential.

Using *effective* milliamperes and *effective* kilovolts, curves for generators *A*, *B*, and *C* for the roentgen-ray emission per effective milliampere are given in Figure 4.

It should be pointed out that for the comparatively small ripple present in the voltage of generator *C*, the difference between the average and effective voltage is so small that it may be neglected. Likewise their variation with tube current is negligible; hence, a single curve for $I/ma.$ (eff.) gives a satisfactory basis of comparison.

In the case of generator *A* the change in emission per milliampere, as the operating current is varied, is present and somewhat erratic as in the case of the peak voltage curves. The percentage change, however, is the least of the three cases given. Similarly in the case of generator *B* the change

equal effective voltages, the emission per milliampere will be sufficiently near the same with all three generators for the effective current and voltage to be used as characteristic of the roentgen-ray emission.

Since the emission per milliampere for all strictly constant potential generators is the same, it is logical that it be referred to as a base. By means, then, of the effective current and effective voltage measurements described, it is possible to relate consistently the roentgen-ray emission excited by the various types of generators.

It is possible to trace the residual variation in roentgen-ray emission per milliampere at lower voltages with the operating current largely to the current-voltage characteristics of the roentgen tube. This will account also for the divergence from the constant potential base line. Figure 5

shows for various applied constant potentials the tube current curves for three values of the filament current, I_f . It is seen that, since the tube current is still increasing about 5 per cent per 30 kv. at 120 kv., saturation is not attained. Consequently,

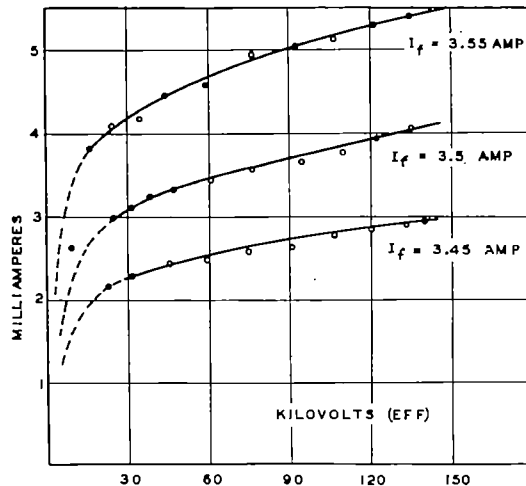


FIG. 5. Tube current—tube voltage characteristics.

with the application of a varying voltage to the tube, the effective current is bound to depend upon the voltage wave form to a varying degree.

This is illustrated in Figure 6 where curves a and b are two hypothetical tube current characteristics, the second of which is ideal in that it reaches saturation at a comparatively low voltage. Curves D , E , and F represent three types of generator

voltage wave form having the same effective voltage, c , which, when applied to tubes having characteristics a and b , produce the tube current wave forms a' and b' respectively for each associated voltage wave. In each of the cases it is seen that the effective current i_a for tube characteristic a is lower than the effective current i_b for characteristic b . Moreover the magnitude of this difference depends upon the generator voltage wave form as shown.

To compare the explanation above with the results found, we note that the experimentally determined tube characteristics in Figure 5 are similar to a in Figure 6; hence, the tube current measured in effective amperes is less than it would have been had the tube reached saturation at as low voltage as for characteristic b .

In Figure 4 the emission per effective milliamperes—which is plotted against effective kilovolts—would accordingly have been less with an ideal characteristic such as b . In other words, the curves plotted would have fallen more nearly along the constant potential curve C (Fig. 4).

To show the relationship between peak and effective kilovolts for different tube currents, the curves A and B in Figure 7 were obtained for the correspondingly designated generators. The straight dashed lines in each set of curves represents the ratio of peak to effective voltage (kv. (peak) = 1.41 kv. (eff.)) for a sine wave.

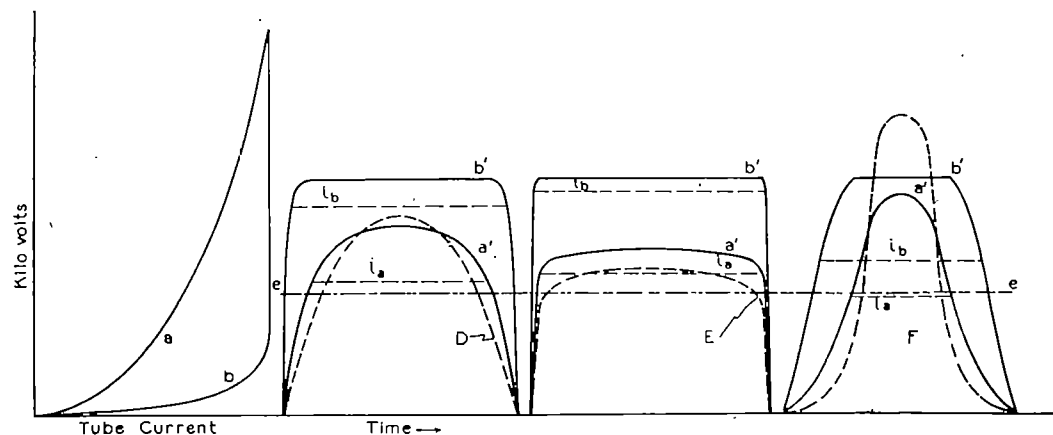


FIG. 6. Effect of tube characteristic and generator wave form on the effective tube current.

It is seen that there is no simple relationship between the two voltage measurements as in the case of a sine wave.

Such a set of curves is very useful when interpreting the behavior of a particular generator under different conditions. This was demonstrated in some earlier work* when comparing the output of generators *A* and *B*.

involved in the therapeutic use of high voltage roentgen rays. The greatest single factor contributing to this has been the voltage measurement, since it has been sometimes assumed that a given roentgen tube, activated by the same voltage (by sphere gap measurement) and passing equal average currents, should yield the same roentgen-ray emission for all similar

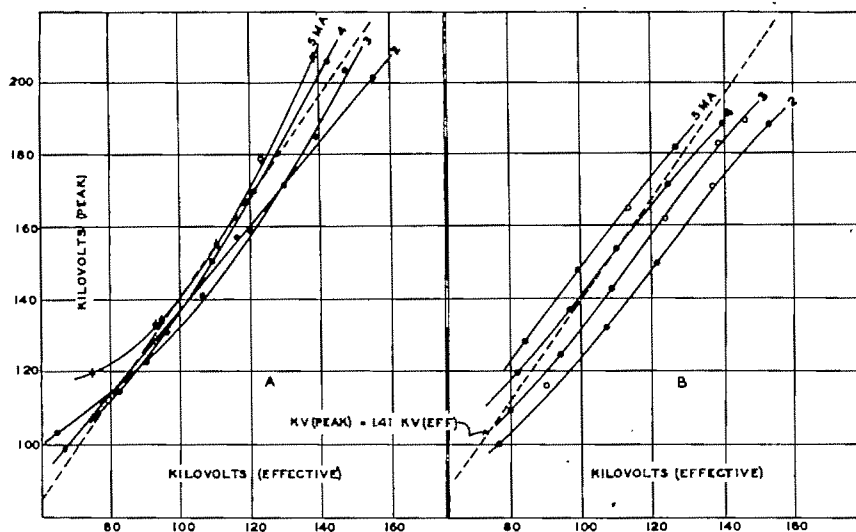


FIG. 7. Relationship between peak and effective kilovolts for two mechanical rectifiers.

The curves also furnish some inference as to the generator wave form, particularly above the point where the tube current characteristic plays an important rôle. Thus, where the points lie below the line $kV. (peak) = 1.41 kV. (eff.)$, they indicate a flat-topped voltage wave form relative to a sine wave; where they lie above that line, a relatively narrow or peaked wave form is indicated. These relations, though only qualitative, are of help in properly adjusting the phase position of the switches on a mechanical rectifier for optimum roentgen tube emission.

IV. DISCUSSION

There has been considerable confusion in interpreting the physical magnitudes in-

generators. We have shown here, however, that the emission may differ by ± 20 per cent under supposedly like conditions.

Although a difference existing between mechanical and constant potential rectifiers has been generally recognized, there has been uncertainty as to any exact relationship between them, with the result that few attempts have been made to correlate treatment factors for the two machines. There has even been a belief that the radiation of one could not be clinically reproduced by the other. The experiments described here show that both generators may be made to produce the same emission (as far as may be deduced from absorption measurements in copper or paraffin) when the tube potentials are properly adjusted.

The present study has been limited thus far to mechanical and "constant potential"

* See Figure 16 with explanation in paper by L. S. Taylor and K. L. Tucker (Footnote 1).

rectifiers. While it is believed by some that mechanical rectifiers will probably be displaced by valve tube rectifiers, the study is of no less value, since with the great variety of valve tube circuits in use there is an equal variety of voltage wave forms produced none of which may be readily correlated as far as they affect the roentgen-ray output of a tube. For example, in addition to "constant potential" there will be half-wave, full-wave, and polyphase rectifiers and voltage doubling circuits such as the La Tour and Villard systems. In some of these the wave form depends upon load to a greater extent than others and, as a consequence, measurements of peak voltage alone will lead to similar discordance now encountered in mechanical rectifiers.

This study reveals that, when the generator potential is measured in effective kilovolts, the roentgen-ray emission of a tube

is equivalent to that produced by very nearly the same constant potential. It is thus possible to express the emission in terms of that obtainable from a constant potential source.

Expressing tube potential in effective kilovolts simplifies the method of expressing radiation quality. For example, when describing radiation quality in terms of the "half-value layer of copper" it is recognized as necessary also to state the voltage. However, as voltages are now measured, even this is inadequate due to the effect of wave form. To indicate quality correctly by the usual absorption methods, the effective voltage should be stated—not the peak voltage.

The cordial cooperation of the Radiological Research Institute and of the American x-ray equipment manufacturers in this work has been very helpful.



ROENTGEN-RAY OUTPUT COMPARISONS OF THERAPY CIRCUITS AND TUBES*

By M. J. GROSS, M.S., and Z. J. ATLEE, B.S.
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THE purpose of this article is to compare the more common types of generating circuits and tubes for therapy use on the basis of roentgen-ray output per given sphere gap kilovoltage and average (meter read) milliamperage. A number of articles on this subject have been written in the last few years but most of them have taken into consideration only one type of roentgen tube and two or, at the most, three circuits. In addition, at least some of the data must be discounted because factors which influence the result have either been overlooked or not completely specified.

APPARATUS AND METHOD

Throughout the entire study as many variables as possible were eliminated by keeping the same overhead system, tube enclosure, dosimeter enclosure, dosimeter, sphere gap, milliammeters, high voltage transformer, primary control, and power supply (Fig. 1). The same operators took data throughout. Arrangements were made whereby it was possible to change from one circuit to another within fifteen minutes. In this way it was possible to make repeated checks with all combinations of circuits and tubes within a short enough time to eliminate the variables of temperature and barometric pressure. Two high voltage transformers, 5 filament transformers, 4 kenotrons, a 0.05 microfarad bank of condensers, and a cross arm mechanical rectifier switch, made possible the following generating circuits (Fig. 2):

- (a) Mechanical rectifier for 200 kv.p., 30 ma.
- (b) Half-wave rectified kenotron for 250 kv.p., 30 ma.
- (c) Full-wave bridge kenotron for 200 kv.p., 30 ma.
- (d) Kenotron condenser voltage doubling circuit for 300 kv.p., 10 ma.

(e) Kenotron condenser voltage tripling circuit for 300 kv.p., 10 ma.

(f) Constant potential doubling circuit for 200 kv.p., 25 ma.

Eight different types of therapy tubes representing several different manufacturers were used in the study.

Measurements in roentgens were made with a Victoreen thimble type removable

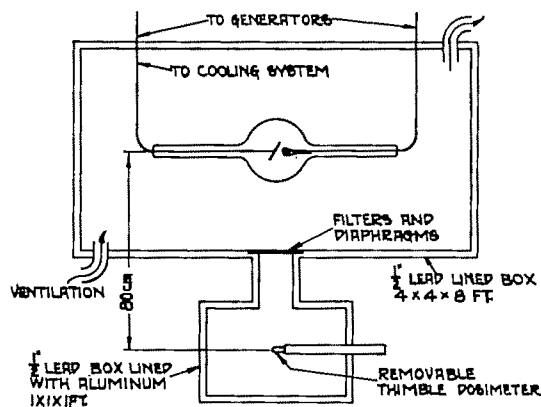


FIG. 1. Diagram of the apparatus showing the tube container and ionization measuring system.

chamber dosimeter. The dosimeter was checked with the manufacturer's standard several times during the study.

DATA AND CONCLUSIONS

Figures 3, 4, 5, 6, 7 and Table I summarize an r comparison of circuits and tubes.

Figure 8 gives a half-value layer comparison of circuits. Data for Figure 8 are obtained from Figure 5.

Table II gives a comparison of the kilovolts peak, and milliamperes required on different circuits and with different tubes to obtain as nearly as possible identical radiation.

From the data it is quite obvious that constant potential gives a greater output

* From the Tube Department, General Electric X-Ray Corporation, Chicago.

than any other type of circuit when the comparison is made on the basis of kilovolts peak, and milliamperes. Qualitatively, this fact is well known. Quantitatively, wide differences have been reported.

The tripling (Witka) circuit is second in order of output to constant potential. Because of other limitations, however, this

circuit has found little commercial application.

The voltage doubling (Villard) circuit is third in order of output. It is being extensively used for very high voltage because with the circuit only about one-half of the roentgen tube voltage needs to be supplied by transformers.

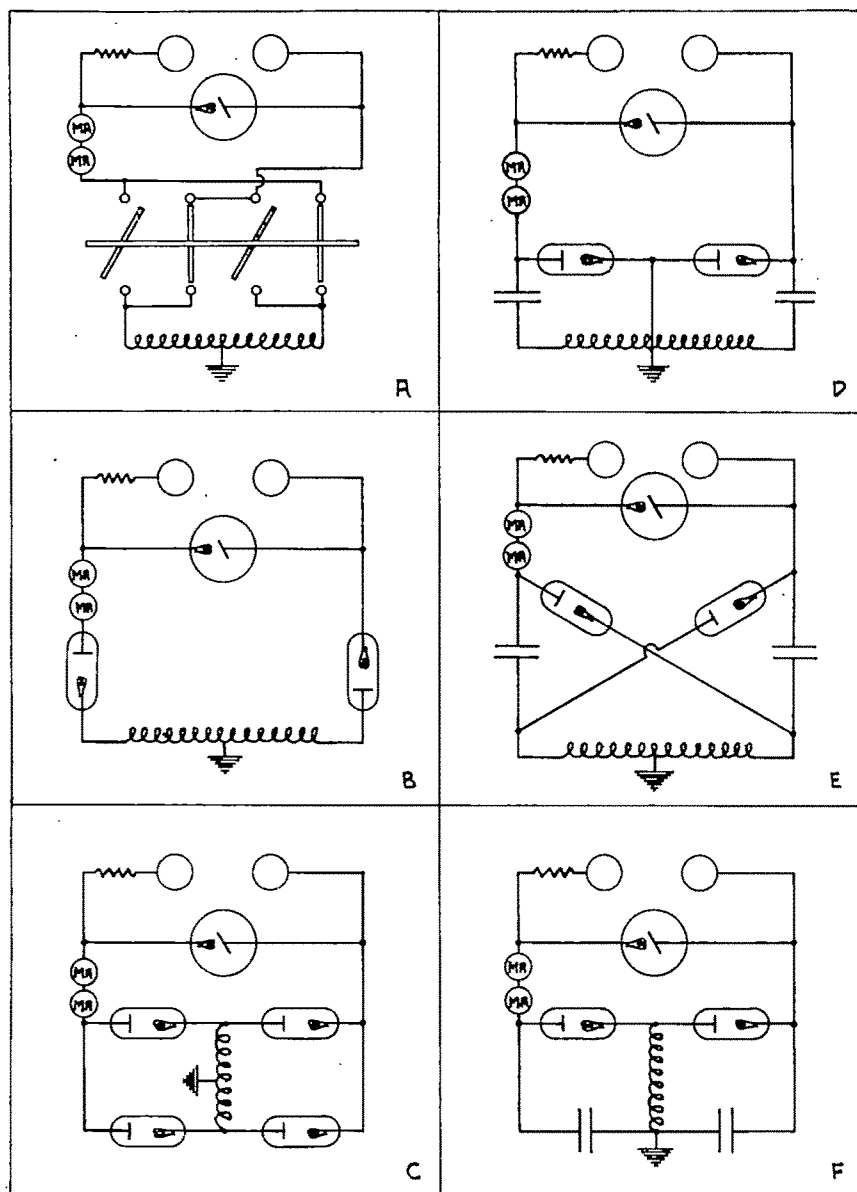


FIG. 2. Diagrams of circuits used in the investigation: (A) mechanical rectifier; (B) half-wave circuit; (C) full-wave circuit; (D) voltage-doubling circuit; (E) voltage-tripling circuit; (F) constant potential.

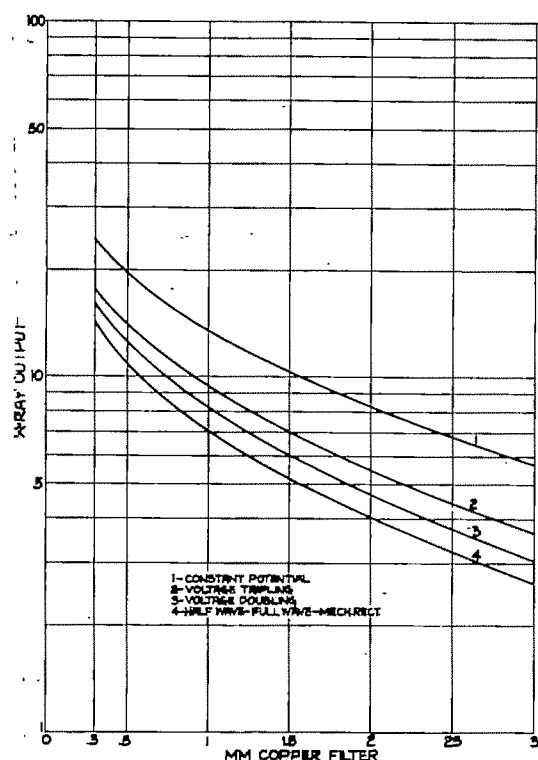


FIG. 3. Roentgen-ray output comparison of circuits: 200 kv.p., 10 ma., water-cooled therapy tube with one-quarter inch glass filter, total anode radiation.

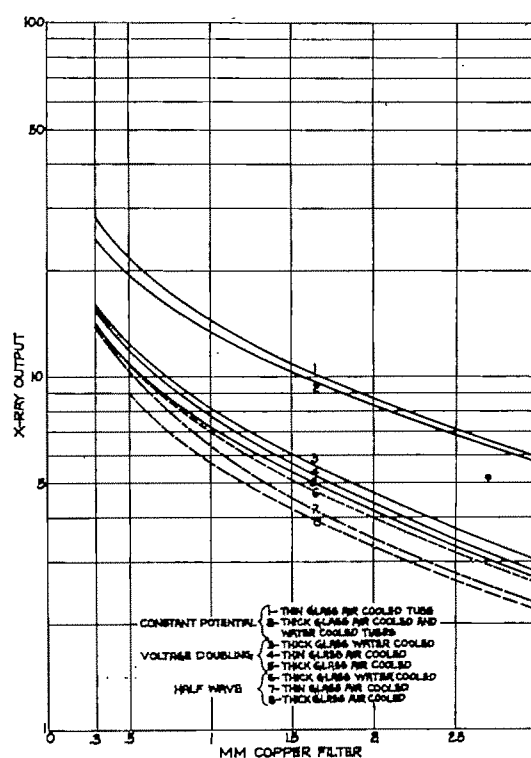


FIG. 4. Roentgen-ray output comparison of circuits and tubes: 200 kv.p., 10 ma., total anode radiation.

No significant differences in r output or quality are found between mechanically rectified, full-wave kenotron, or half-wave kenotron rectified circuits, that is, no differences greater than 5 per cent. It might be noted that this agrees with conclusions reached in the diagnostic range of voltages to the effect that these same cir-

cuits are of equal roentgenographic speed for all practical purposes. Differences may be found where equipment of different manufacture are compared, and where different overhead systems, tubes and power supplies are used.

Any quantitative comparison of different circuits depends upon the type of tube

TABLE I
QUANTITATIVE COMPARISON OF CIRCUITS ON THE BASIS OF r OUTPUT AT 200 kv.p., 10 ma.

Circuit	Tube (Water-Cooled or Air-Cooled)	Ratio of r output to that obtained on constant potential			
		0.5 mm. Copper	1.0 mm. Copper	2.0 mm, Copper	3.0 mm. Copper
Constant potential	Water-cooled	1.0	1.0	1.0	1.0
Constant potential	Air-cooled	1.0	1.0	1.0	1.0
Voltage doubling	Water-cooled	0.64	0.60	0.56	0.52
Voltage doubling	Air-cooled	0.56	0.53	0.50	0.46
Half-wave*	Water-cooled	0.55	0.51	0.48	0.45
Half-wave	Air-cooled	0.45	0.42	0.40	0.38

* Full-wave and mechanical rectifier approximately same as half-wave.

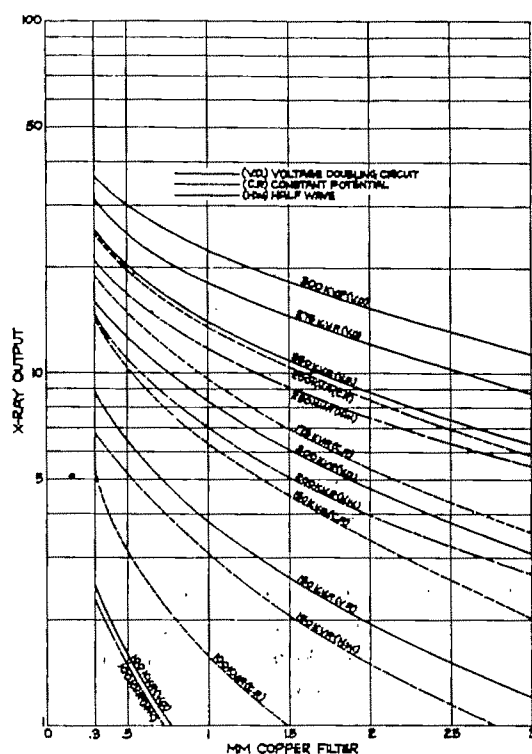


FIG. 5. Copper absorption curves for various generators. Water-cooled therapy tube with one-quarter inch glass filter, 10 ma.

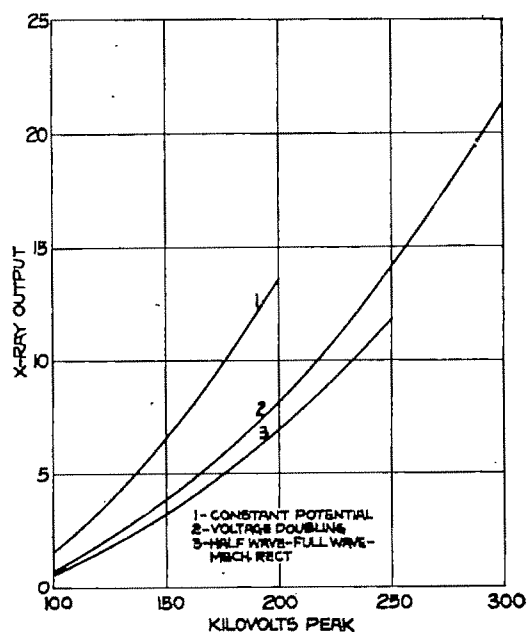


FIG. 6. Roentgen-ray output as a function of the kilovoltage peak on different circuits. Water-cooled therapy tube with one-quarter inch glass filter, 1 mm. of copper external filter.

used (Fig. 4). For example, it will be noted that a half-wave rectified circuit with a water-cooled therapy tube gives approximately the same output per ma. as a

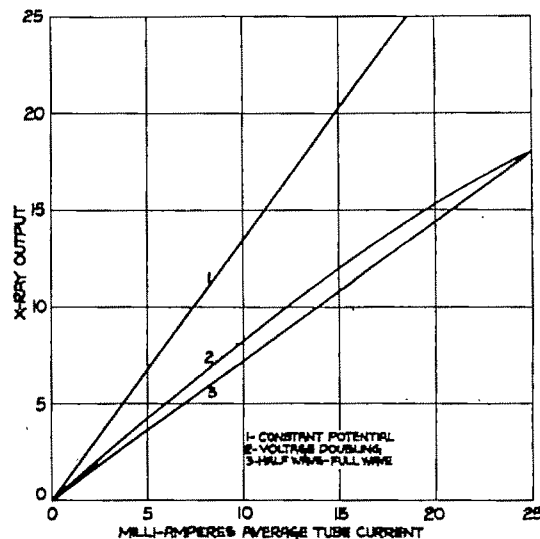


FIG. 7. Roentgen-ray output as a function of average tube current. Water-cooled tube with one-quarter inch glass filter: 200 kv.p., 1 mm. copper external filter.

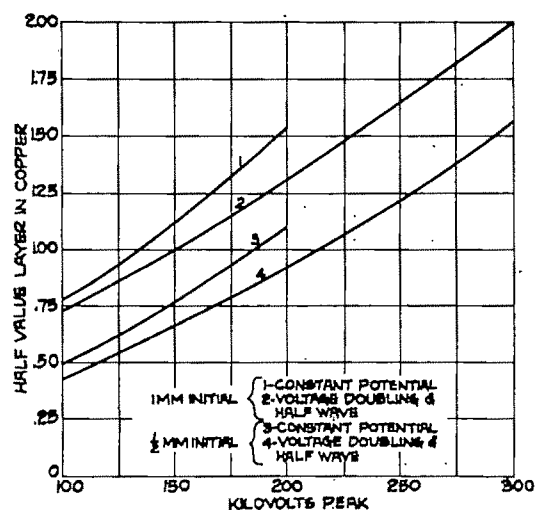


FIG. 8. Half-value layer comparison of circuits as a function of kilovoltage peak. Water-cooled tube, one-quarter inch glass filter.

voltage-doubling circuit with an air-cooled tube. On the other hand, a half-wave circuit with an air-cooled tube gives only 70 per cent the output of a doubling circuit with a water-cooled tube.

Two factors cause variation in r output from different types of tubes operating on the same circuit. The most obvious of these is glass absorption, which with the tendency toward thick glass may lower the

Measurements on a number of air-cooled therapy tubes from several different manufacturers indicate that they all fall into one class as far as amount of distortion is concerned. Any differences in r out-

TABLE II
Kilovoltage Peak and Milliamperage Necessary to Duplicate the Half-Value Layer and Quantity of Radiation Obtained from a Constant Potential Circuit at 175 kv.p., 5 ma.

Circuit	Tube	Initial Filter for Half-value Layer	kv.p.		ma.	
			Sphere Gap	Per Cent Increase over Constant Potential	Average Current	Per Cent Increase over Constant Potential
Voltage doubling	Water-cooled	0.5	202	15	5.7	15
Voltage doubling	Water-cooled	1.0	205	17	5.5	10
Voltage doubling	Air-cooled	0.5	202	15	6.7	34
Voltage doubling	Air-cooled	1.0	205	17	6.3	25
Half-wave	Water-cooled	0.5	202	15	6.7	34
Half-wave	Water-cooled	1.0	205	17	6.4	28
Half-wave	Air-cooled	0.5	202	15	7.9	58
Half-wave	Air-cooled	1.0	205	17	7.6	52

output as much as 10 per cent. A one-quarter inch thick glass envelope of pyrex has an equivalent copper absorption at 200 kv.p. of approximately 0.2 mm. of copper. Inasmuch as a filter is always used in therapy this inherent filter in the tube offers no disadvantage. It should, however, be taken into consideration.

The second factor is distortion in wave form of the current and voltage caused by the tube itself. A recent article¹ has shown that the grid action of stray electrons on the envelope of an air-cooled therapy tube causes a gradually decreasing r output until a constant glass temperature is reached. After this stable condition is reached its r output per ma. may be from 10 to 20 per cent lower than that of a water-cooled tube.

¹ Gross, M. J. Transient K.V.P. and r output from an air-cooled therapy tube, *Radiology*, Jan., 1933, 20, 14-17.

put are found to be due to variations in glass absorption.

On a constant potential source of voltage there can be no wave form distortion and this factor is eliminated, all tubes giving the same r output except for differences due to glass absorption (Fig. 4).

SUMMARY

It is realized, of course, that these comparisons allow no conclusions to be drawn, as to the relative merits of the circuits and tubes without additional knowledge as to the maximum kilovoltage and milliamperage each will stand, their reliability, first cost, life, and many other factors. It is thought, however, that the data given may eliminate confusion and make possible, to some extent at least, a better comparison of techniques on different equipments and tubes.

THE PHYSICAL FOUNDATIONS OF CHEST ROENTGENOGRAPHY*

PART I

By R. B. WILSEY
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WITHOUT question, the chest offers one of the most complex problems in roentgenographic technique of any part of the human body. Many of the requirements for a satisfactory chest roentgenogram conflict with each other, so that a gain in one respect is apt to be accompanied by a loss in another. It is to be expected that the relative merits of the various factors involved would be judged differently by different workers in this field, and that there would be a wide variance of opinion as to the most suitable compromise of these factors, giving the best all-round quality of roentgenogram for diagnostic purposes.

The importance of the roentgen examination in the diagnosis of chest conditions has led to serious effort to improve the technique of chest roentgenography, in the hope that it could be made to yield more exact and complete information, particularly in doubtful cases. In order to attack this problem most effectively, it seems desirable to analyze the situation in the light of the underlying physical principles, examining critically the influence of each technical factor and the various combinations of factors so far as such information is available or can readily be obtained.

Much remains to be done in the precise determination of the laws governing the various technical factors in chest roentgenography and in securing the fundamental data upon which any final solution of the problem must rest. The present study must therefore be confined to the significance of the main physical phenomena involved, omitting many refinements of secondary interest. For instance, the following statements are known to be only approximations to the truth; they are sufficiently re-

liable, however, to justify the conclusions that will be drawn from them: (1) Roentgenographic exposure should be increased in proportion to the square of the target-film distance. (2) The correct exposure for chest roentgenograms in milliamperere-seconds varies inversely as the cube of the tube voltage. (3) For any given exposure time, the energy that can safely be applied to the focal spot is proportional to the area of the focal spot. These and other approximate laws will be used in the various phases of this study.

For the purpose of giving information about the structures portrayed, the quality of the roentgenographic image is determined chiefly by two factors, contrast and definition or sharpness. Knowledge of a third factor, magnification, or variation in magnification causing distortion, is also important in the estimation of dimensions in the structures examined. Distortion in the roentgenographic image is less important than either contrast or definition, and is a much simpler problem than the others. Distortion, therefore, will be discussed first.

DISTORTION

The various parts of the subject roentgenographed are enlarged according to the geometry of shadow projection (Fig. 1), the parts farthest from the film being enlarged the most. This variation in the enlargement of different parts of the subject constitutes distortion. Distortion is lessened by increasing the target-film distance, but cannot be entirely eliminated by this means. The relations between object-film distance, target-film distance, and distortion in the single roentgenogram have been treated quite thoroughly by Andrew and Warren.¹ For the present purpose, it will be sufficient

*Communication No. 508 from the Kodak Research Laboratories

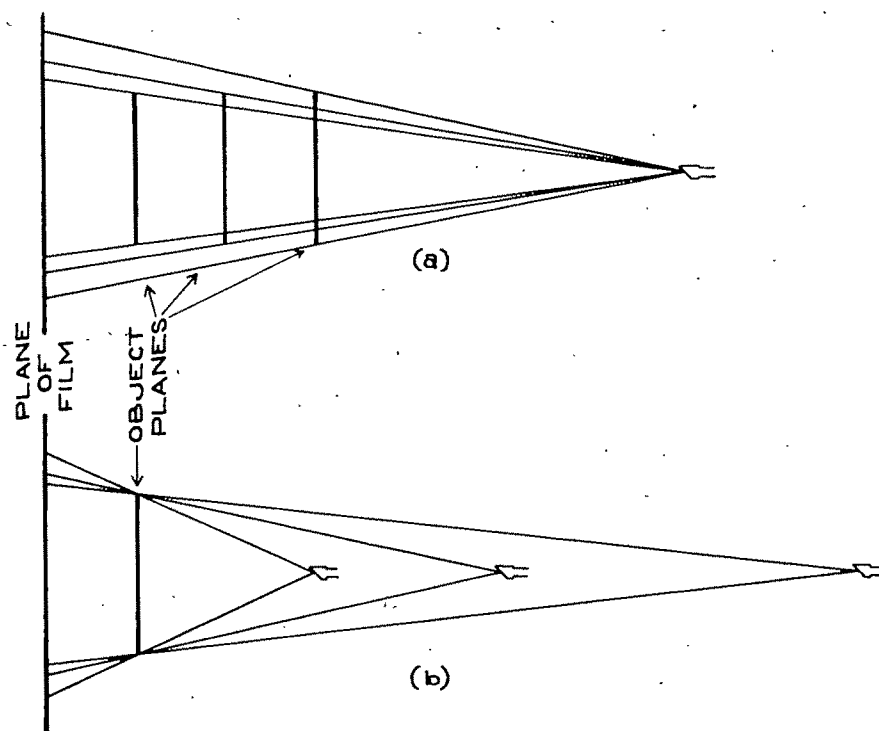


FIG. 1. Geometry of shadow projection. (a) Effect of varying object-film distance upon enlargement. (b) Effect of varying target-film distance upon enlargement.

to consider the influence of target-film distance upon distortion for two typical object-film distances, 4 and 8 inches, as shown by the curves of Figure 2.

It is obvious that with increasing target-film distance, improvement in the matter

of distortion becomes progressively less, following a law of diminishing return. Most of the decrease in enlargement has occurred within the 4-foot distance; beyond this, the enlargement diminishes very slowly. On the other hand, the cost

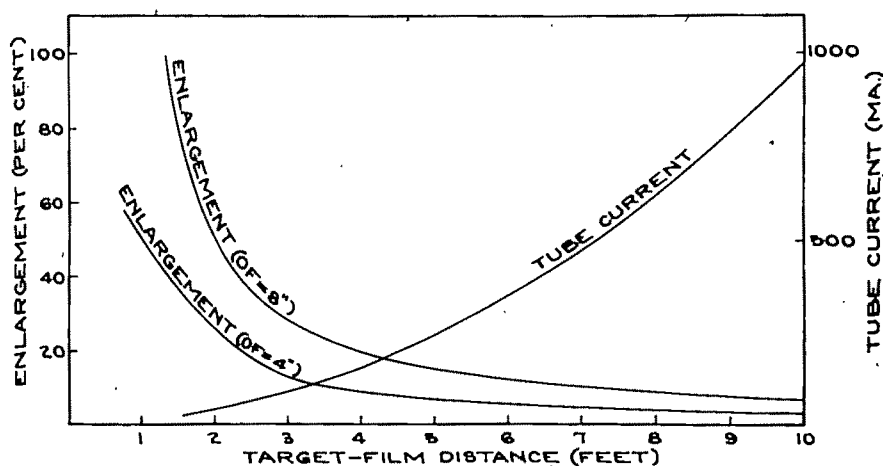


FIG. 2. Enlargement as a function of target-film distance for object-film distances of 4 and 8 inches; also tube current as a function of target-film distance (assuming tube voltage and exposure time kept constant).

of this improvement in terms of the roentgen tube current required for the exposure becomes rapidly higher, growing as the square of the target-film distance. Certainly the improvement in distortion beyond a target-film distance of 6 feet is slight, and it is questionable whether such improvement is worth the cost in greater energy of exposure. The reduction of dis-

film distance. At a viewing distance of 4 feet or more, the eye is apt to have difficulty in seeing the finer details in the roentgenogram. Furthermore, stereoscopes are not commonly built to allow viewing distances greater than 28 or 30 inches. The problem then is to find the stereoscopic tube shift to use at a long target-film distance such as will cause minimum distor-

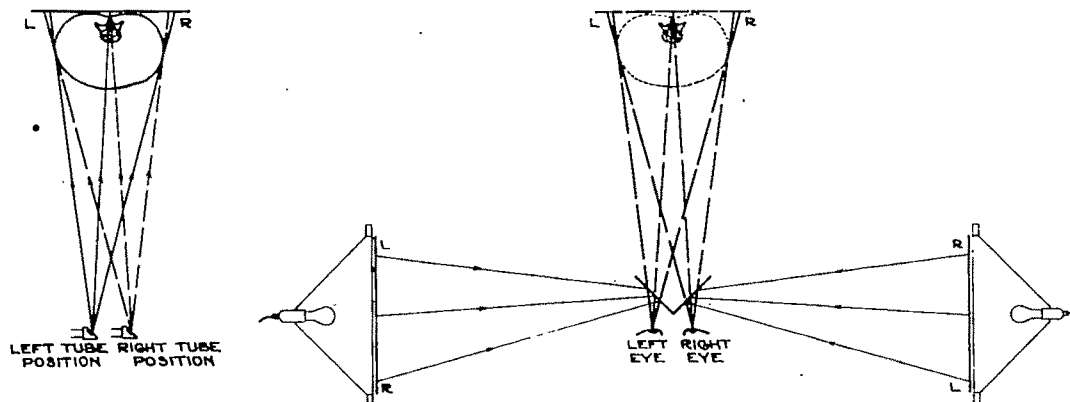


FIG. 3. To avoid distortion in the stereoscopic image, there should be exact geometric correspondence between the conditions of exposing stereoscopic films and of viewing the finished roentgenograms in the Wheatstone stereoscope. The tube shift should equal the interpupillary distance, and the eye-film distance should equal the target-film distance.

tortion by any desired increase of target-film distance may, however, be carried out without the sacrifice of any other qualities of the roentgenogram, provided compensation for the greater exposure is made by increasing the tube current, and not by increasing tube voltage or exposure time. If the limited power of the roentgen-ray machine makes a 6-foot target-film distance impracticable, this distance may be reduced to 5 or 4 feet with but little increase in distortion.

Stereoscopic roentgenograms offer another possibility of minimizing distortion. In fact, a rigorously correct stereoscopic procedure completely eliminates distortion in the stereoscopic image,⁴ as is illustrated in Figure 3. In chest roentgenography at long target-film distances, however, the use of a strictly correct stereoscopic method would require that, in viewing the roentgenograms in the stereoscope, the eye-film distance be equal to the target-

film distance. At a viewing distance of 4 feet or more, the eye is apt to have difficulty in seeing the finer details in the roentgenogram. Furthermore, stereoscopes are not commonly built to allow viewing distances greater than 28 or 30 inches. The problem then is to find the stereoscopic tube shift to use at a long target-film distance such as will cause minimum distor-

tion in the stereoscopic image when the roentgenograms are viewed at a distance as short as 25 or 30 inches. One method commonly proposed is to make the ratio of tube shift to interpupillary distance the same as the ratio of target-film distance to eye-film distance, as illustrated in Figure 4(a).

In this case, the eye-film distance is taken as 25 inches, the target-film distance 72 inches, and the interpupillary distance 2.5 inches. According to the above rule, $\text{tube shift} / 2.5 \text{ inches} = 72 / 25$, or the tube shift should be 7.2 inches. The relation between the form of the stereoscopic image and that of the original subject may readily be derived by a graphical method.⁵ In Figure 4(a) the outline of the stereoscopic image, in dotted line, is shown for an elliptically shaped object (solid line) 8 inches thick. The distortion of a portion of the subject next the film of 4 inches thickness is also shown. It is apparent that all

parts of the image are narrower and flatter than the corresponding portions of the subject. These deviations from correct size and proportions can be diminished by the use of a slightly greater tube shift, determined by the construction shown in Figure 4(b). Lines from the center of the subject are drawn through the eye points, and at any chosen target-film distance, the roentgen tube shift is determined by the corresponding spacing between the two lines. This tube shift gives greater "separation" of the two stereoscopic views, as well as producing less distortion than the method shown in Figure 4(a).

Table I gives the values of stereoscopic tube shifts for various eye-film and target-film distances, as derived by the construction of Figure 4(b), assuming the center of the chest to be 4 inches from the film.

If the tube shift be governed by either of the constructions of Figure 4, distortion in the stereoscopic image decreases with diminishing target-film distance to the point where the latter equals the eye-film distance; in this case, distortion is eliminated completely in the stereoscopic image under the correct viewing conditions (Fig. 3).

DEFINITION OF SHARPNESS

Definition or sharpness is probably the most important physical characteristic of the roentgenographic image. For instance, if excised lungs are reinflated and roent-

TABLE I

Target-Film Distance	Stereoscopic Tube Shift for Eye-Film Distance of		
	25 in.	28 in.	30 in.
4 ft.	5½ in.	4½ in.	4½ in.
5	6½	5½	5½
6	8½	7½	6½
7	9½	8½	7½
8	11	9½	8½

genographed on plain roentgen film with a fine focus tube, much more information about the finer lung structures is shown than is obtainable in the chest roentgenogram of a live patient. These fine details are due chiefly to the lack of movement, and in lesser degree to the use of a fine focus tube and the omission of intensifying screens which the immobilization makes possible. Such detail in ordinary chest

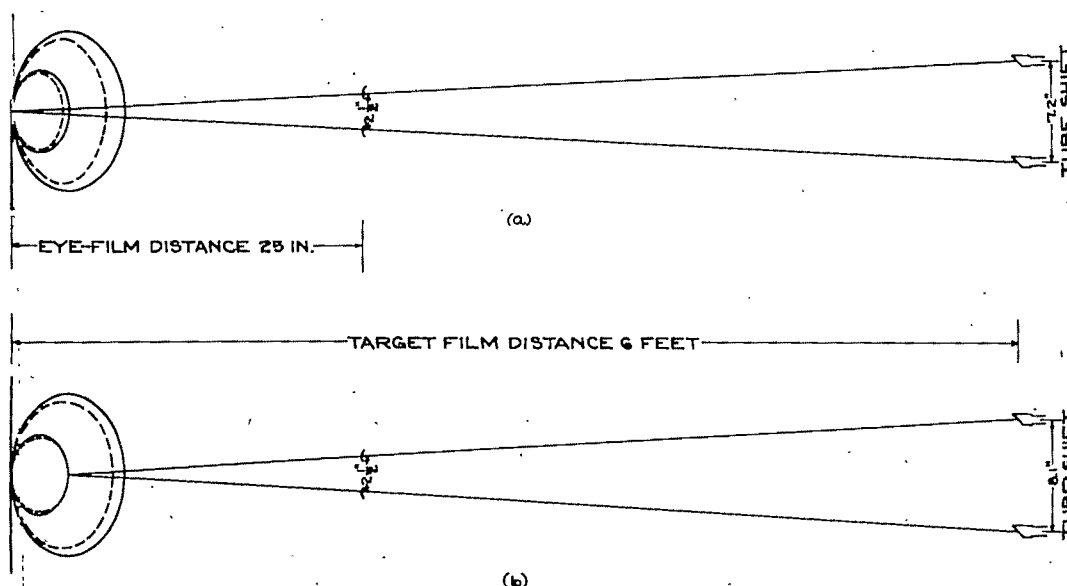


FIG. 4. Comparison of stereoscopic image (dotted line) with outline of original subject in case (a) the ratio of tube shift to interpupillary distance is made equal to ratio of target-film distance to eye-film distance, and (b) the tube shift is determined by lines drawn through eye points from center of subject.

roentgenograms would greatly enhance their diagnostic value. Of course, it is not possible to secure this same sharpness of detail in the roentgenography of the patient since movement of the lung tissues with the heart beat, the superposition of

exposure times be short in order to minimize the blurring due to movement. A shorter exposure time, however, requires a greater tube current, and consequently a larger focal spot, with the result that any gain in sharpness won by shortening the

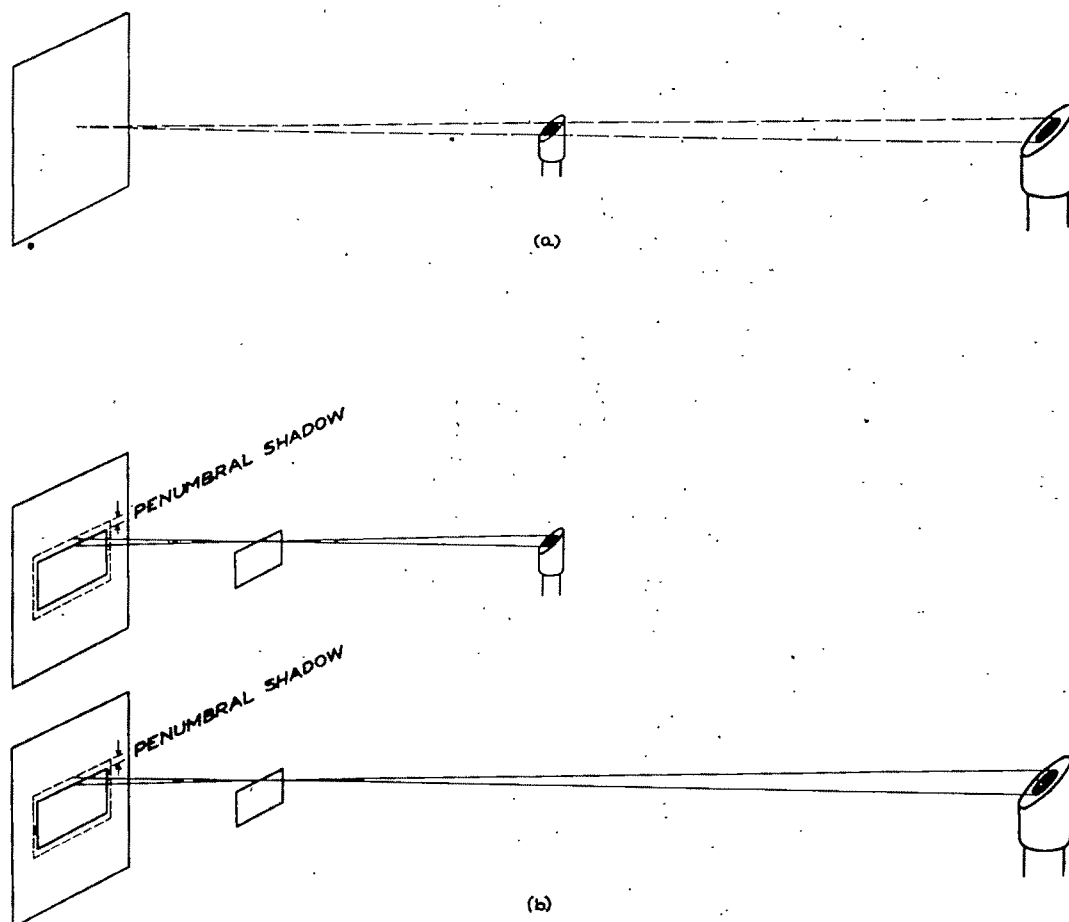


FIG. 5. (a) Focal spot width must be made proportional to target-film distance to allow for the necessary changes in tube current. (b) Under this condition, the width of the penumbral shadow is practically unaffected by target-film distance.

the roentgen-ray absorption of the chest walls, and scattered radiation, all interfere with the delineation of the finer lung details. However, the superior detail shown in the roentgenograms of excised lungs serves to illustrate the value of improved sharpness in the roentgenographic image.

The mutually conflicting requirements in chest roentgenography impose a severe burden upon the roentgen tube. The movement of the lung tissues necessitates that

exposure time is counteracted more or less by the greater size of focal spot required. The increase of target-film distance to decrease distortion also necessitates a greater tube current and a larger focal spot. In any case the focal spot must be as small as possible consistent with the energy passed through it. In other words, *to secure the best definition in chest roentgenography, the focal spot must be operating at or near its maximum load capacity.* By maximum load

capacity is meant the maximum load the tube will stand consistent with a reasonable life of the tube, as specified by the manufacturer's rating. This rating increases rather gradually with decrease of exposure time.³

This principle governs practically the whole consideration of sharpness in chest

width of the diffused edge of a shadow (penumbral shadow) cast by each of these focal spots is practically the same. Any advantage in sharpness of outline which would otherwise be obtained by increasing the target-film distance is almost wholly lost by reason of the larger focal spot required to carry the greater tube current.

TABLE II

Target-film distance (ft.).....	3	4	5	6	7	8
Area of focal spot (sq. mm.).....	7.1	12.6	19.7	28.3	38.5	50.2
Diameter of focal spot (mm.).....	3	4	5	6	7	8
Width of penumbra (mm.).....	0.86	0.80	0.77	0.75	0.74	0.73

roentgenography. It is of interest to examine the application of this principle to the effect of target-film distance upon roentgenographic sharpness. Other factors remaining the same, the energy passed through the roentgen tube must increase in proportion to the square of the target-film distance. The focal spot area must be increased approximately in proportion to the energy.³ This means that if the angle of the target face remains constant, the diameter of the focal spot must be increased

It is possible to calculate the width of penumbra from the following relation:

$$\frac{\text{Width of penumbra}}{\text{Width of focal spot}} = \frac{\text{object-film distance}}{\text{object-target distance}}$$

which follows from the simple geometry of the case. Table II gives the results of such calculations for an object 8 inches from the film, assuming that focal spot width must increase in proportion to the target-film distance. The exposure conditions are such that a focal spot (circular) of 3 mm.

TABLE III

Target-film distance (ft.).....	3	4	5	6	7	8
Anode slope (degrees).....	30.2	23.5	19.3	16.2	14.0	12.4
Area of focal spot (sq. mm.) on target face	21.4	33.0	59.4	85.5	116.5	152
Apparent area of focal spot as projected along central ray (sq. mm.).....	10.8	15.2	19.6	23.9	28.2	32.7
Apparent diameter of focal spot (mm.)..	3.9	4.4	5.0	5.5	6.0	6.4
Width of penumbra (mm.).....	1.11	0.88	0.77	0.69	0.62	0.59

in direct proportion to the target-film distance, with the result that increasing the target-film distance has scarcely any effect upon roentgenographic sharpness. For instance, in Figure 5(a), one focal spot is twice as far from the film as the other; its diameter is twice, and its area four times that of the nearer focal spot. Doubling the target-film distance necessitates a 4-fold increase in tube current, which can just be accommodated by the quadrupled area of focal spot. Figure 5(b) shows that the

diameter (as seen in the line of the central ray) is required at a target-film distance of 3 feet.

Thus, increasing the target-film distance from 4 to 8 feet diminishes the width of diffusion at the edge of a shadow (penumbra) by 0.07 mm., an amount which would not be perceptible in the average chest roentgenogram.

In the above calculations it is assumed that the angle of the target face remains unchanged throughout. The use of the line

focus principle, however, permits the angle between the target face and the central ray to be diminished as the target-film distance is increased, and thereby makes possible a greater gain in roentgenographic sharpness. It has been pointed out by Andrus and Hambleton³ that if the angle of the target face is made too small, there will be excessive variations in sharpness in different parts and along different directions of the roentgenogram, owing to the

calculations are given in Table III, and apply to a 14-inch width of film, with exposure conditions assumed to require, at a 5-foot target-film distance, a focal spot (circular) of 5 mm. apparent diameter as viewed along the central ray; the object-film distance is taken as 8 inches.

Thus, by suitable application of the line focus principle, increase of target-film distance can be made to yield a slight advantage in sharpness. The gain in sharp-

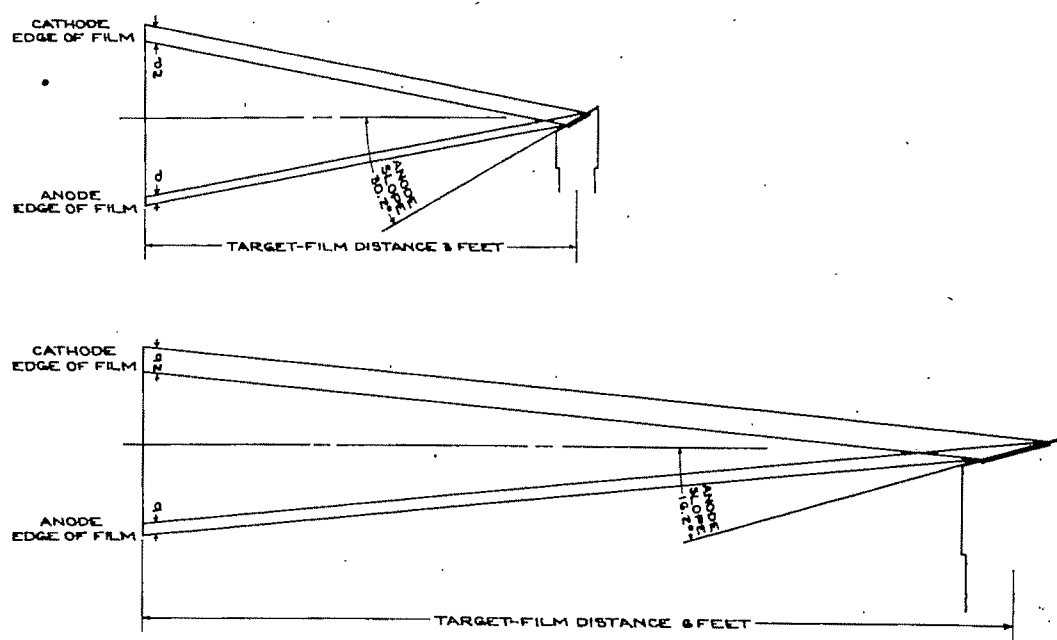


FIG. 6. To avoid excessive variations in sharpness in various portions, and along different directions, in the roentgenogram, the maximum projection of the focal spot on the cathode edge of the film should not be more than twice the minimum projection of the focal spot on the anode edge of the film (Andrus and Hambleton³). This criterion permits a smaller anode slope at the longer target-film distance.

variations in the effective form and size of the focal spot as projected upon different portions of the film. To avoid these variations, they adopt the criterion that the maximum projection of the focal spot at the cathode edge of the film shall not be more than twice its minimum projection at the anode edge of the film (Fig. 6). With this condition governing the angle between target face and central ray, the width of the penumbra shadow cast by the central ray may be readily computed for various target-film distances. The results of such

ness beyond a 6-foot distance is inappreciable and the advantage of the 6-foot over the 4-foot distance is small, amounting to 0.2 mm. in lesser width of penumbra.

Most of the lung tissue is nearer the film than the 8-inch object-film distance assumed in these calculations; penumbral shadows, therefore, will generally be smaller than those computed in Tables II and III, and the differences due to variation of target-film distance will also be less. Furthermore, in these calculations, no account has been taken of the fact that smal-

ler focal spots will stand a slightly greater load in proportion to their area than larger focal spots. In any case, it appears questionable whether any material gain in sharpness can be secured by an increase of target-film distance.

Any development which enables a smaller focal spot to carry the tube load required for a chest roentgenogram will further diminish the influence of target-film distance upon definition.

It is apparent from these considerations that target-film distance is a relatively unimportant factor in chest roentgenography. There is little to be gained either in sharpness or freedom from distortion, by the use of distances greater than 4 feet, and no appreciable gain beyond 6 feet, as long as focal spot size is made as small as possible consistent with the energy to be passed through it. On the other hand, such slight gains as are possible by an increase in target-film distance are made at a cost of greatly increased exposures and correspondingly greater requirements in the power of the roentgen machine.

SUMMARY

To give information about the structures portrayed, the important characteristics of the roentgenographic image are contrast, sharpness, and distortion.

The decrease in distortion in the single roentgenogram with increase of target-film distance follows a law of diminishing return, while the cost of such improvement in the energy required for the exposure increases rapidly, according to the square of the target-film distance. Most of the de-

crease in distortion occurs within a 4-foot target-film distance; beyond this, distortion diminishes very slowly. For the reduction of distortion there appear to be no appreciable advantages in target-film distances greater than 6 feet, and only a slight advantage in distances greater than 4 feet.

To minimize distortion in the stereoscopic image, a method is described for the determination of stereoscopic tube shift with long target-film distances when the roentgenograms are to be viewed in the stereoscope at a short distance (25 to 30 inches).

To secure the best definition in chest roentgenography, the roentgen tube should be operated at or near its maximum load capacity. Under this condition, variation in target-film distance has practically no effect upon sharpness, provided the angle of the target face is fixed, and has only a slight effect in case the anode slope is adjusted in accordance with the target-film distance.

REFERENCES

1. ANDREW F. D., and WARREN, S. L. A study of the distortion in roentgenograms taken at various target film distances. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1929, 22, 332-338.
2. ANDRUS, P. M., and HAMBLETON, A. The capacity of x-ray tubes as influenced by the geometric design of the focal spot. *Radiology*, 1932, 18, 521-531.
3. BOUWERS, A. Self-protecting tubes and their influence on the development of x-ray technic. *Radiology*, 1929, 13, 191-206.
4. SNOOK, H. C. The practical use of the Wheatstone stereoscope. *AM. J. ROENTGENOL.*, 1919, 6, 39-47.
5. WILSEY, R. B. Stereoradiography and distortion. *Radiography & Clinical Photography*, Sept.-Oct., 1932, 8, 2-5.



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For Program of American Congress of Radiology: See this issue, page 250.

Date of Meeting: September 25-30, 1933.

Place of Meeting: Palmer House, Chicago Ill., Scientific Sessions, Scientific and Commercial Exhibits will all be held in this Hotel.

* For Officers and Standing Committees of the American Roentgen Ray Society and the American Radium Society usually carried on this page, see the April, 1933, number of the Journal.

† Combined meeting of: American Roentgen Ray Society, American Radium Society, American College of Radiology, Radiological Society of North America.

EDITORIALS

A CENTURY OF PROGRESS

CHICAGO and its spectacular, fascinating "A Century of Progress," the finest extravaganza of achievement in a century, beckons invitingly to the hundreds of radiologists who will attend the American Congress of Radiology from September 25 to 30, inclusive, at the Palmer House, Chicago.

Eighty-two miles of exhibits, hundreds of stellar attractions in the realms of science, education, history, romance, fun, foods, music, thrills and adventure comprise the Fair. Built on 424 acres of made land, stretching for three miles along the shore line of Lake Michigan, nestled almost in the shadows of the big Loop skyscrapers, "A Century of Progress" has been the world's busiest spot since the opening day. And it is the world's most colorful spot by day, and the world's brightest spot by night.

Brilliant, though softly blending—blues, reds, greens, golds, bronzes, silvers, blacks and whites—twenty-five colors in all have been employed by artists to give the grounds a blazing kaleidoscopic spectacle. At night miles of neon tubes, carefully concealed, indirect lighting, flood the great expanses of the buildings with varicolored lights. Spotlights, color fountains, mushroom ground lights all add to the glory of the sight.

Telling the story of the growth of chemistry, physics, mathematics, geology, medicine, surgery and pharmacy graphically, the hundreds of exhibits in the Hall of Science are some of the most comprehensive at the Fair. Among other things, there are sixty physics exhibits; there is a \$10,000 "robot" who tells of the mechanical movements of his viscera by an illuminated "interior" view of himself; the earth sci-

ences, appropriately epitomized by a "Giant Clock of the Ages," are shown on the screen in the center of the dial, while the minute hand ticks off two billion years of earth history.

Exhibits in jewelry, cosmetics, office furniture, the graphic arts, mineral industries and textiles are housed in the General Exhibits group; while the General Motors building has a complete assembling plant for automobiles. Long miles of exhibits in the Hall of States tell the wonders of Alaskan fisheries, of Hawaii's amazing fruits, California's beauty, Illinois' products. All in all more than thirty states present their stories in surprising detail. The United States Government Building stands in the center of the horseshoe formed by the Hall of States, and exhibits showing the strides made in the various branches of government in the last 100 years are to be found.

Illinois as host state to the nation has erected the only state building at the Fair, and its "welcome house" tells among other things the story of Lincoln through the comprehensive collection of Lincolniana to be found in three of the Host Building rooms. Stained glass windows, made by the re-discovered ancient Phoenician process, pictures colorfully Illinois scenes, history, and accomplishments. There is an auditorium where lectures are held from time to time, and the largest and most comfortable lounge in the Exposition takes up the entire south wing of the building.

Other feature attractions of the World's Fair are the exhibits of visiting nations, as Italy, Japan, China, Sweden, Czechoslovakia, Ukrania, the beautiful reproduction of a Belgian Village, and others. The Hall of Social Science telling the Story of

Man, the Radio and Communication Building, the Electrical Building, the Home Planning Group, are all particularly interesting. And so are the Mayan Temple, Chrysler Building, Horticultural Building,

Hall of Religion, Firestone Building, the Sky Ride, the Dairy and Agricultural buildings, Fort Dearborn, and the Alpine gardens.

JAMES T. CASE

AMERICAN CONGRESS OF RADIOLOGY

THE Executive Council of the American Congress of Radiology, scheduled for the Palmer House, Chicago, September 25-30, inclusive, has written to as many radiologists in the United States and Canada as are listed in the headquarters' office and to many in Central and South America and abroad, inviting them to attend the Congress. All radiologists who have received the invitation are urged to send in immediately their photograph and information for the Congress album, a copy of which will be given to each member; and to send in their registration blank filled out and fee in connection, in order that they may become members of the Congress and receive free a copy of the beautiful book "Science of Radiology" which is being prepared in connection with the Congress. All arrangements are being made by the local committee, and communications may

be addressed to Dr. Benjamin H. Orndoff, Chairman, 2561 N. Clark street, Chicago. Physicians and other scientists interested are invited to communicate with Dr. Orndoff.

It will be recalled that the four national radiological societies, the American College of Radiology, the American Radium Society, the American Roentgen Ray Society, and the Radiological Society of North America, are meeting jointly this year and that the most comprehensive scientific program ever given in the Americas is being prepared. Sessions will be held only until 2 p.m. each day, in order that the visiting physicians and scientists may attend the Century of Progress on the lake front. Ample accommodations for all guests will be arranged for at the Palmer House, Chicago.

JAMES T. CASE





HENRY K. PANCOAST

PRESIDENT OF THE AMERICAN CONGRESS OF RADIOLOGY, 1933

HENRY K. PANCOAST, M.D.

HENRY K. PANCOAST was born in Philadelphia, February 26, 1875. His father, Seth Pancoast, also a physician, and a graduate of the University of Pennsylvania, practiced in Philadelphia. He was, in his later years, interested in various fields outside of medicine, and his wife who was before marriage, Miss Susan George Osborn, assisted him in his work, often doing extensive translating for him in Greek, Latin and German.

Dr. Pancoast's parents both belonged to the Society of Friends and from them he has inherited the characteristics so often noticed in those of Quaker ancestry—an absolute "level headedness" and common sense which in his case are augmented by a kindliness of nature that has endeared him to his friends. He received his entire preliminary education at Friends Central School, Philadelphia, graduating at the head of his class in 1892. From his early boyhood it was definitely known that he had made up his mind to study medicine, but he had lost his parents before graduating from school, and felt it necessary to take a position for a time, before entering Medical School.

Fortunately for him, a premedical college course was not compulsory at that time and after two or three years of working in a bank (an experience that has undoubtedly been of the utmost value to him) he entered the Medical School of the University of Pennsylvania, graduating in 1898. He served as interne for two years and began to practice in the autumn of 1900. It was in May, 1902, that he was asked to take charge of the Roentgen Department of the University of Pennsylvania Hospital, succeeding Dr. Charles Lester Leonard, and the so-called "department," was at that time housed in one dark room in the basement of the Hospital. In April, 1903, Dr. Pancoast married Clara L. Boggs of Baltimore, Maryland, who has shared

in every way his professional ambitions.

From 1901 to 1904, Dr. Pancoast served as Assistant Instructor in Clinical Surgery and Assistant Demonstrator in Surgery. From 1905 to 1911 he was lecturer on "Skiagraphy" and in 1912 he was appointed to the Chair of Roentgenology in the Medical School of the University of Pennsylvania. He was Secretary of the American Roentgen Ray Society in 1912, and President in 1913; Secretary of the American Radium Society 1917-1918, and President in 1919.

The Department of which Dr. Pancoast is chief has grown from its original one room to a laboratory of international reputation and has developed first, because of his own unceasing labor and unselfish devotion to his work, and secondly, because he has been singularly fortunate in his choice of associates who are young men of very exceptional ability and who share with him an untiring interest in the work. Dr. Pancoast never relaxes mentally and has had the faculty of imparting much of this same strenuous interest to his fellow workers who can never for a moment fail to realize that his work comes first in his life. He is never apart from it and even on so-called vacations, he is invariably accompanied by ponderous tomes whose aid he solicits from time to time as he plans and works on "papers" for various meetings, and when he can be persuaded to "play" it is always more or less obvious that play is considered in the light of a favor to his comrades and at the first opportunity there is sure to be a return to the work that he loves so well.

The outstanding achievements of Dr. Pancoast in the field of roentgenology thoroughly qualify him as the President of the American Congress of Radiology, the first meeting of its kind to be held in America.

C. B. P.

SOCIETY PROCEEDINGS CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

- AMERICAN ROENTGEN RAY SOCIETY**
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Annual Meeting: Chicago, Ill., Sept. 25-30, 1933.
- AMERICAN COLLEGE OF RADIOLOGY**
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual meeting: Chicago, Ill., Sept. 25-30, 1933.
- SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION**
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.
Annual meeting: Cleveland, Ohio, 1934.
- RADIOLOGICAL SOCIETY OF NORTH AMERICA**
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.
Annual meeting: Chicago, Ill., Sept. 25-30, 1933.
- RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY**
Secretary, Dr. R. T. Taylor, Los Angeles, Calif.
Meets on the third Wednesday of each month at the California Hospital.
- RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION**
Secretary, Dr. C. H. Hercock, 20 S. Dunlap St., Memphis, Tenn.
Annual meeting: Richmond, Va., November, 1933.
- BROOKLYN ROENTGEN RAY SOCIETY**
Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N. Y.
Meets monthly on first Tuesday, October to April.
- BUFFALO RADIOLOGICAL SOCIETY**
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.
Meets second Monday of each month except during summer months, place of meeting selected by the host.
- CHICAGO ROENTGEN SOCIETY**
Secretary, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.
- CINCINNATI RADIOLOGICAL SOCIETY**
Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.
- CLEVELAND RADIOLOGICAL SOCIETY**
Secretary, Dr. M. A. Thomas, Medical Arts Bldg.
Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.
- DETROIT ROENTGEN RAY AND RADIUM SOCIETY**
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.
- FLORIDA RADIOLOGICAL SOCIETY**
Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.
Meetings held twice a year, May and November.
- ILLINOIS RADIOLOGICAL SOCIETY**
Secretary, Dr. L. M. Hilt, Myers Bldg., Springfield, Ill.
Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY

- Secretary*, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.
- MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS**
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Kalamazoo, Mich., October, 1933.
- MILWAUKEE ROENTGEN RAY SOCIETY**
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.
Meets first Friday in October, December, February and April. Place of meeting designated by the president.
- MINNESOTA RADIOLOGICAL SOCIETY**
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.
- NEW ENGLAND ROENTGEN RAY SOCIETY**
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.
- NEW YORK ROENTGEN SOCIETY**
Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.
- NORTH CAROLINA ROENTGEN RAY SOCIETY**
Secretary, Dr. Major Fleming, Rocky Mount, N.C.
Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.
- CENTRAL NEW YORK ROENTGEN RAY SOCIETY**
Secretary, Dr. H. S. Bull, 604 Masonic Temple, Auburn, N. Y.
Three meetings a year—January, May and November.
- PENNSYLVANIA RADIOLOGICAL SOCIETY**
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
- PHILADELPHIA ROENTGEN RAY SOCIETY**
Secretary, Dr. Karl Kornblum, 3400 Spruce St.
Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.
- ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.**
Secretary, Dr. W. W. Fray, Strong Memorial Hospital.
Meets monthly on second Thursday from October, 1932, to May, 1933 inclusive, at 7:45 at the Rochester Medical Association Building.
- ST. LOUIS ROENTGEN CLUB**
Secretary, Dr. W. K. Mueller, University Club Bldg.
Meets first week of each month. Time and place of meetings designated by president.
- SOUTH CAROLINA X-RAY SOCIETY**
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston, S. C.
Meets at time and place of South Carolina State Medical Association.
- TEXAS RADIOLOGICAL SOCIETY**
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.
- UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY**
Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

VIRGINIA ROENTGEN RAY CLUB

Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.

Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA

Secretary, Dr. Luis Farfías, Animas 110, Havana, Cuba.

Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.

Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

INDIAN RADIOLOGICAL ASSOCIATION

Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta.

Meets annually in January, and at such places and times as the Council may appoint.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY

Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgium).

Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE

Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.

Secretary for German language, Dr. Scheurer, Molzgasse, Biel.

Meets annually in different cities.

SOCIÉTÉ FRANÇAISE D'ELECTROTHERAPIE ET DE RADIOLOGIE MÉDICALE

Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA

Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)

Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.

Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY

Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETÀ ITALIANA RADIOLOGIA MEDICA

Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banul Maracine 30 Bucarest, Rumania.

Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson.

Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin.

Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.

Meets monthly on the first Monday at 8 o'clock; the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. B. Krynski, 11 Zielna St.

Meets once a month except in the summer time.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN

Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY

Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK

Secretary, Dr. H. Scheuermann, Copenhagen.

Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND

Meets in Helsinki.

VIENNA SOCIETY OF ROENTGENOLOGY

Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION

c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY

Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan. Meets bi-monthly on third Sunday.

SCIENTIFIC PROGRAM OF THE AMERICAN CONGRESS OF RADIOLOGY

September 25 to 30, 1933, Inclusive

Palmer House, Chicago, Illinois

*Arranged by the Scientific Program
Committee*

GEORGE E. PFAHLER, M.D., *Chairman*,
Philadelphia, Pa.

WILLIAM H. CAMERON, M.D., New York
City

DONALD S. CHILDS, M.D., Syracuse, N.Y.

EDWIN C. ERNST, M.D., St. Louis, Mo.

BYRON H. JACKSON, M.D., Scranton, Pa.

BURTON J. LEE, M.D., New York City

JOHN T. MURPHY, M.D., Toledo, Ohio

EUGENE P. PENDERGRASS, M.D., Philadel-
phia, Pa.

ROLLIN H. STEVENS, M.D., Detroit, Mich.

September 25, 1933

GRAND BALL ROOM MONDAY, 9:00 A.M.

GENERAL MEETING*

Call to order and presentation of first five
Speakers: BENJAMIN H. ORNDORFF, M.D.,
Chairman of the Executive Council.

Address of Welcome: AUSTIN A. HAYDEN, M.
D., President of the Chicago Medical Society.

Address: RUFUS C. DAWES, President of A
CENTURY OF PROGRESS Exposition.

Address: HUGH S. CUMMING, M.D., D.Sc.,
Surgeon General, U.S. Public Health Service.

Address: MORRIS FISHBEIN, M.D., Editor,
Journal of American Medical Association.

Intermission—15 Minutes

Address: HENRY K. PANCOAST, M.D., Presi-
dent, American Congress of Radiology,
Professor of Radiology, University of Penn-
sylvania.

Address: FRANKLIN H. MARTIN, M.D., Di-
rector General, American College of Surgeons.

Address: "Radiosensitivity of Tumor Tissue,"
JAMES EWING, A.M., M.D., Sc.D., Professor
of Pathology, Cornell University; Patholo-
gist to Memorial Hospital.

Induction of JOHN T. MURPHY, M.D., Presi-

dent-Elect, by William A. Evans, M.D.,
President American Roentgen Ray Society.
Induction of W. HERBERT MCGUFFIN, M.D.,
President-Elect, by Byron H. Jackson,
M.D., President Radiological Society of
North America.

Induction of ROLLIN H. STEVENS, M.D.,
President-Elect, by Burton J. Lee, M.D.,
President American Radium Society.

Induction of HENRY K. PANCOAST, M.D.,
President-Elect, by Albert Soiland, M.D.,
President American College of Radiology.

Brief Report of Committees and Special An-
nouncements. (Note—Following the opening
meeting, the special committee meetings of
the various component Radiological Societies
will be announced by the officers of the Soci-
eties, and may take place sometime after
adjournment each day.)

2:00 P.M. Adjournment

September 26, 1933

GRAND BALL ROOM TUESDAY, 9:00 A.M.

Section "A"

CHEST DISEASES

Presiding Officer, Dr. John T. Murphy,
President, American Roentgen
Ray Society

9:00—"The Roentgen Ray in the Study of
Pathology of Pulmonary Tuberculosis,"
KENNON DUNHAM, M.D., Cincinnati,
Ohio. Associate Professor of Medical
Department; Director of Tuberculosis,
University of Cincinnati.

9:20—"Correlation of Clinical and Roent-
genological Observation in Pulmonary
Tuberculosis," LAWRASON BROWN, M.
D., Saranac Lake, N.Y. Consultant
to the Trudeau Sanatorium.
HOMER L. SAMPSON, Roentgenologist
to the Trudeau Sanatorium.

9:40—"Tuberculosis in Children" F. MAURICE
McPHERDAN, M.D., Philadelphia, Pa.
Assistant Professor of Medicine, Henry
Phipps Institute.

10:00—"The Roentgen Examination of the
*Heart: A Critical Study of the Frontal
Silhouette*" FRED J. HODGES, M.D.,
Ann Arbor, Mich. Professor of Roent-
genology, University of Michigan.
CARLETON B. PEIRCE, M.S., M.D.,
Assistant Professor of Roentgenology
—University of Michigan.

* At this meeting, there will be a general photograph made,
and each will be numbered. It is requested that each person
present write the name and address on the card found on the
chair, which will be collected immediately.

10:20—"Serial Bronchography in the Early Diagnosis of Bronchial Carcinoma," PEDRO L. FARINAS, M.D., Havana, Cuba. Chief of the X-ray Department, National Hospital.

10:40—"Where is the Diaphragm?" WILLIAM H. STEWART, M.D., New York City. Visiting Physician, Roentgen Department, Lenox Hill and Lutheran Hospitals.

11:00 A.M. RECESS

11:20—"Lymphoblastoma of the Chest and Elsewhere" GEORGE W. HOLMES, M.D., Boston, Mass. Clinical Professor of Roentgenology, Harvard Medical School, Roentgenologist, Massachusetts General Hospital.

11:40—"Roentgen Diagnosis of Interlobar Pleurisy" (Lantern Slides) CHARLES A. WATERS, M.D., Baltimore, Md. Associate in Roentgenology, Johns Hopkins Hospital.

12:00—"Accessory Sinus Diseases in Relation to Chest Diseases," W. WALTER WASSON, A.B., M.D., Denver, Colo. Attending Radiologist, Children's Hospital and St. Anthony Hospital. HAROLD D. WALTZ, M.D., Fellow in Radiology, Child Research Council.

12:20—"Non-Tuberculous Inflammation of the Lungs," W. WARNER WATKINS, M.D., Phoenix, Arizona. Director, Pathological Laboratory; Radiologist, St. Joseph's Hospital and St. Luke's Home for Tuberculosis.

12:40—"Surgical Condition within the Chest, Under Roentgen Observations" WILLIAM A. EVANS, M.D., Detroit, Michigan. President, American Roentgen Ray Society.

1:00—"Practical Suggestion on the Use of Iodized Oil in Bronchography" LEROY SANTE, M.D., St. Louis, Missouri. Professor of Radiology, St. Louis Medical School. Chief Radiologist, St. Louis City Hospital; Radiologist, St. Mary's Hospital Group.

1:20—"Scattered X-rays in Chest Roentgenography," R. B. WILSEY, M.A., Rochester, New York. Physicist, Kodak Research Laboratories.

1:30—"Bronchiectasis from the Roentgenologist's Standpoint" FRED H. CLARK,

M.D., Aspinwall, Pa. Roentgenologist, U. S. Veterans Bureau Hospital.

1:40—"A Roentgenological Technique for the Determination of the Efficiency of Pulmonary Ventilation: Relations of Linear and Area Measurements of the Lung Field to Clinical Determinations of Pulmonary Capacity," WALTER FRAY, M.S., M.D., Rochester, N.Y. Assistant Professor of Medicine (Radiology); Assistant Radiologist—Strong Memorial Hospital.

2:00 P.M. ADJOURNMENT

September 26, 1933

RED LACQUER ROOM TUESDAY, 9:00 A.M.

Section "B"

PHYSICS, BIOLOGY, AND THERAPEUTICS

Presiding Officer, DR. ROLLIN H. STEVENS, President, American Radium Society

9:00—"The Genealogy of the X-ray," A. W. CRANE, M.D., Kalamazoo, Michigan.

9:20—"Data Concerning Three Years Experience with 600 kv. (Peak) Roentgen Therapy," SEELEY G. MUDD, B.S., M.D., Pasadena, California. Research Associate in Radiology, California Institute of Technology.

CLYDE K. EMERY, B.A., M.D., Research Fellow in Radiology, California Institute of Technology.

ORVILLE M. MELAND, M.D.

WILLIAM E. COSTOLOW, M.D.

9:40—"Some Practical Applications of the Recent Advances in Physics," W. D. COOLIDGE, Ph.D., Schenectady, N.Y. Director of Research, General Electric Company.

E. E. CHARLTON, Ph.D., Research Engineer—General Electric Company.

10:00—"Energy Considerations in Medium and High Voltage Therapy," CHARLES C. LAURITSEN, Ph.D., Pasadena, California. Associate Professor of Physics, California Institute of Technology.

10:20—"Application of Physical Measurements in Clinical Irradiation," LAURISTON S. TAYLOR, Washington, D.C. Associate Physicist, Head, X-Ray Laboratory, National Bureau of Standards.

- 10:40—"Training for Radium Therapy," WM. H. CAMERON, M.D., New York City. Secretary—American Radium Society; Instructor Radium Therapy, Dermatological Department, New York University and Bellevue Hospital Medical College.

11:00 A.M. RECESS

- 11:20—"Physical and Biological Characteristics of 700 kv. X-Rays," G. FAILLA, D.Sc., New York City. Physicist, Memorial Hospital.
- 11:45—"Distribution of X-rays within the Human Body," EDITH H. QUIMBY, M.A., New York City. Associate Physicist, Memorial Hospital.
- MURRAY M. COPELAND, M.D., Clinical Fellow in Cancer Research, Memorial Hospital.
- R. C. WOODS.
- 12:05—"The Measurement of Gamma Rays in Roentgens," G. FAILLA, D.Sc., New York City. Physicist, Memorial Hospital.
- L. MARINELLI, B.Sc.
- 12:20—"Heublein's Method of Continuous Irradiation of the Entire Body in the Treatment of Generalized Neoplasms," LLOYD F. CRAVER, M.D., New York City. Attending Physician, Memorial Hospital.
- WILLIAM S. MACCOMB, M.D.
- 12:40—"The Problems of Protection and Their Solution in Short Wave Therapy," T. LEUCUTIA, M.D., Detroit, Michigan. Associate Roentgenologist, Harper Hospital.
- K. E. CORRIGAN, Ph.D., Physicist, Harper Hospital.
- 1:00—"Preliminary Study of the Effect of Artificial Fever Upon Hopeless Tumor Cases," STAFFORD L. WARREN, M.D., Rochester, N. Y. Associate Professor of Medicine; Radiologist, Strong Memorial Hospital.
- 1:20—"Studies on Composite X-ray Filters," A. MUTSCHELLER, Ph.D., Long Island City, N.Y. Instructor and Consulting Physicist, Columbia University Post-Graduate Medical School; Director of Research, Westinghouse X-Ray Laboratories.
- 1:40—"An Apparatus for the Production of Very High Voltage X-Rays," D. M.

SLOAN, Berkeley, California. Whiting Fellow in Physics, University of California.

J. J. LIVINGOOD, Research Associate of Department of Physics, University of California.

FRANK M. EXNER, Physicist, Institute Cancer Research, Columbia University.

2:00 P.M. ADJOURNMENT

September 27, 1933

GRAND BALL ROOM WEDNESDAY, 9:00 A.M.

Section "A"

GASTROINTESTINAL DISEASES

Presiding Officer, Dr. H. HERBERT MCGUFFIN, President, Radiological Society of North America

- 9:00—"Duodenitis and its Roentgenologic Characteristics," B. R. KIRKLIN, B.S., M.D., Rochester, Minnesota. Associate Professor of Radiology, University of Minnesota (Mayo Foundation); Head of Section on Roentgenology and Director of Division of Radiation, Mayo Clinic.
- 9:20—"Roentgenology of Duodenal Ulcer. (a) The Behavior of the Stomach and Duodenum. (b) Methods of Obtaining Outline Deformity in Roentgenograms," HOLLIS E. POTTER, M.D., Chicago, Illinois. President, Chicago Roentgen Society.
- 9:40—"Duodenal Diverticulosis—A Report of Thirty-Six Cases," JOHN D. LAWSON, M.D., Sacramento, California.
- 10:00—"The Redundant Duodenum," A Roentgenologic Study (8 Lantern Slides), MAURICE FELDMAN, M.D., Baltimore, Maryland. Assistant Professor of Gastroenterology, University of Maryland; Associate Roentgenologist, Sinai Hospital.
- 10:20—"An Analysis of 1000 Consecutive Examinations of the Stomach and Duodenum from the Clinical, Roentgenological, and Surgical Viewpoint; with Particular Reference to the Incidence, Diagnosis, and Treatment of Ulcer and Carcinoma of the Stomach," NELSON M. PERCY, M.D., Chicago, Illinois. Professor of Surgery, University of Illinois College of Medicine; Surgeon-in-Chief, Augustana Hospital.

DAVID S. BEILIN, M.D., Radiologist, Augustana Hospital.

- 10:40—"Functional Disturbances of the Colon in Relation to the Roentgen Diagnosis of Organic Colonic Disease," JAMES T. CASE, M.D., D.M.R.E., Professor of Radiology, Northwestern University Medical School; Attending Staff, Passavant, Grant and Evanston Hospitals; Editor, *Annals of Roentgenology*.

11:00 A.M. RECESS

- 11:20—"The Small Intestines: Correlation of Anatomic, Pathologic, and Roentgenologic Findings," LEWIS GREGORY COLE, M.D., New York City.

- 11:40—"An Evaluation of a New Procedure in the Study of the Small Intestine," EUGENE P. PENDERGRASS, M.D., Philadelphia, Pa. Assistant Professor of Radiology, University of Pennsylvania. W. OSLER ABBOTT, M.D., Instructor in Medicine and Assistant Instructor in Pharmacology—University of Pennsylvania.

- 12:00—"Cholecystography with Tetraiodophenolphthalein by Mouth; Experience with Regard to Success and Untoward Reactions" and "Physiology of the Gall Bladder: Cholecystography Shows no Psychic Emptyings," R. R. NEWELL, M.D., San Francisco, California. Professor of Medicine, Stanford University School of Medicine. EDWARD LEEF, M.D., Instructor in Medicine, Stanford University School of Medicine.

- 12:20—"Roentgen Diagnosis of Diseases of the Colon: An Evaluation of Methods" HARRY M. WEBER, B.S., M.D., Rochester, Minnesota. Instructor in Radiology, University of Minnesota (Mayo Foundation), Associate in Section on Roentgenology, Mayo Clinic.

- 12:40—"Roentgenologic Studies of Amoebic Colitis," J. J. VALLERNO, M.D., Panama, R. P.

- 1:00—"Dangers of Fluoroscopy and Methods of Protection Against Them," E. T. LEDDY, M.D., Rochester, Minnesota

- 1:20—"Colon Studies. VII. Variations in the Fixation of the Ceco-Colon: Their Clinical Significance," JOHN L. KANTOR, M.D., New York City. Associate in Medicine, Columbia University; At-

tending Physician, Gastro-Intestinal Diseases, Vanderbilt Clinic; Gastroenterologist and Associate Roentgenologist, Montefiore Hospital.

SAMUEL SCHECHTER, M.D., Assistant Attending Roentgenologist, Metropolitan Hospital.

- 1:40—"Viscerocardiac Reflexes," LESTER LEVYN, M.D., Buffalo, New York. WERNER J. ROSE, M.D.

2:00 P.M. ADJOURNMENT

September 27, 1933

RED LACQUER ROOM WEDNESDAY, 9:00 A.M.

Section "B"

CANCER OF THE MOUTH, SKIN AND MISCELLANEOUS

Presiding Officer, Dr. JOHN T. MURPHY, President, American Roentgen Ray Society

- 9:00—"Irridation Treatment of Cancer of the Lip and Mouth, Technique and Results," CHARLES L. MARTIN, E.E., M.D., Dallas, Texas. Professor of Radiology, Baylor University Medical School; Director, Baylor Tumor Clinic; Radiologist, Baylor Hospital.

- 9:20—"The Roentgen-Ray and Radium Treatment of Cancer of the Lip," BERNARD P. WIDMANN, M.D., Philadelphia, Pa. Assistant Professor of Radiology, Post Graduate School of Medicine, University of Pennsylvania, Chief Radiologist, Philadelphia General Hospital.

- 9:40—"Management of Cancer of the Mouth and the Cervical Lymphatics," DOUGLAS QUICK, M.D., New York City.

- 10:00—"Protracted Irradiation in the Treatment of Neoplasms of the Mouth and Pharynx—A Comparison between X-Rays, Five Gram Pack and Small Radium Pack," Radiation Therapy Service, New York City. Bellevue Hospital, Division of Cancer, Department of Hospitals.

IRA KAPLAN, B.Sc., M.D., Visiting Radiation Therapist, Clinical Professor of Surgery, New York University, Bellevue Hospital Medical College.

RIEVA ROSH, M.D., Radiation Therapist.

MILTON FRIEDMAN, M.D., Assistant Radiation Therapist.

CARL B. BRAESTRUP, B.Sc., P.E., Physicist.

- 10:20—"The Treatment of Carcinoma of the Pharynx, Tonsil and Extrinsic Larynx by Divided Doses of Roentgen Therapy," HAYES E. MARTIN, M.D., New York City. Assistant Attending Surgeon, Memorial Hospital.

ROBERT F. McNATTIN, M.D., Fellow in Clinical Research, Memorial Hospital.

- 10:40—"Roentgen Therapy of Epithelioma of the Pharynx and Larynx," MAURICE LENZ, M.D., New York City. Associate Radiotherapist, Presbyterian Hospital; Attending Radiotherapist, Montefiore Hospital.
CORNELIUS G. COAKLEY, M.A., M.D., Professor of Oto-Laryngology, Columbia University, College of Physicians and Surgeons.

ARTHUR PURDY STOUT, M.D., Associate Professor of Surgery, Columbia University; Attending Surgical Pathologist, Presbyterian Hospital.

11:00 A.M. RECESS

- 11:20—"The General and Medical History of Electricity Told With Old Books Taken from My Library," LEO PARISEAU, M.D., Montreal, Quebec.

- 11:40—"Radiology and the Radiologist," EDWARD H. SKINNER, M.D., Kansas City, Missouri. Chief, Department of Radiology, St. Luke's Hospital.

- 12:00—"Three years of 300 kv. Cancer Therapy," J. ERNEST GENDREAU, M.D., Montreal, Quebec.

- 12:20—"Cancer of the Skin," GEORGE W. GRIER, M.D., Pittsburgh, Pa. Associate Professor of Roentgenology, University of Pittsburgh; Roentgenologist, Presbyterian Hospital; Passavant Hospital; St. John's Hospital; Elizabeth Steel Magee Hospital; Pittsburgh Diagnostic Clinic; Falk Clinic.

- 12:40—"Results of Irradiation in Diseases of the Skin," JOSEPH JORDAN ELLER, M.D., New York City.

- 1:00—"A Review of Angiomas (Birth Marks) Treated During the Last Fifteen Years, With Analysis of End Results," WILLIAM S. NEWCOMET, M.D., Philadelphia, Pa. Radium Therapist, Jeffer-

son Hospital; Radiologist, Presbyterian, Oncologic and Rush Hospitals.

- 1:20—"The Malignant Diseases of the Thyroid Gland," URSUS V. PORTMANN, M.D., Cleveland, Ohio. Director, Department of Radiation Therapy, Cleveland Clinic Foundation.

1:40—

2:00 P.M. ADJOURNMENT

September 27, 1933

GRAND BALL ROOM WEDNESDAY, 8:30 P.M.

Convocation of the newly elected Fellows of the American College of Radiology conducted by the officers:

President.....HENRY K. PANCOAST, M.D.
Vice President..W. WALTER WASSON, M.D.
Treasurer.....HENRY SCHMITZ, M.D.
Historian.....CHARLES G. SUTHERLAND, M.D.

Executive Secretary

.....BENJAMIN G. ORNDOFF, M.D.
Brief Address by the President, HENRY K. PANCOAST, M.D.

Caldwell Lecture—"The Diagnosis and Treatment of Carcinoma of the Lung," EVARTS A. GRAHAM, M.D., St. Louis, Missouri, Professor of Surgery, Washington University Medical School; Surgeon-in-Chief, Barnes and St. Louis Children's Hospital.

Conducted by the Officers of the American Roentgen Ray Society:

President...JOHN T. MURPHY, M.D.
First Vice President

.....SHERWOOD MOORE, M.D.

Second Vice President

.....ROBERT DRANE, M.D.

Secretary...EUGENE P. PENDERGRASS, M.D.

Treasurer...EDWARD L. JENKINSON, M.D.

September 28, 1933

GRAND BALL ROOM THURSDAY, 9:00 A.M.

Section "A"

DISEASES OF BONES, JOINTS AND BONE TUMORS

Presiding Officer, Dr. ROLLIN H. STEVENS, President, American Radium Society

- 9:00—"Seventy Cases of Five-Year Cures in Sarcoma of Bone," (Lantern Slides), CHARLES F. GESCHICKTER, M.D., Baltimore, Maryland. Surgical Pathologi-

- cal Laboratory, Johns Hopkins Hospital.
- 9:20—"Changes in the Lower Extremity Bones in Association with Arteriovascular Disease," MAURICE M. POMERANZ, M.D., New York City. Radiologist, Hospital for Joint Diseases.
- HENRY L. JAFFE, M.D., Pathologist, Hospital for Joint Diseases.
- 9:40—"Injuries of the Spine, Both Acute and Chronic," HOWARD P. DOUB, M.D., Detroit, Michigan. Roentgenologist—Henry Ford Hospital.
- 10:00—"Parathyroid Disease," LAWRENCE REYNOLDS, M.D., Detroit, Michigan. Assistant Roentgenologist, Harper Hospital; Roentgenologist, Children's Hospital of Michigan.
- E. R. WITWER, M. D., Assistant Roentgenologist, Harper Hospital and Children's Hospital of Michigan.
- 10:20—"Osteomalacic Diseases in Monkeys and Man, a Metabolic and Roentgenographic Study," RALPH S. BROMER, M.D., Philadelphia, Pa.
- E. P. CORSON-WHITE, M.D. (By invitation) IRVIN STEIN, M.D. (By invitation).
- 10:40—"X-Ray Evidences of Necrosis of the Head of the Femur Following Intracapsular Fractures of the Neck," D. B. PHEMISTER, M.D., Chicago, Illinois. Department of Surgery—University of Chicago.

11:00 A.M. RECESS

- 11:20—"Infectious Granulomata of the Bones and Joints with Special Reference to Coccidioidal Disease," RAY A. CARTER, M.A., M.D., Los Angeles, California. Roentgenologist, Los Angeles County General Hospital; Associate Professor, Roentgenology, Medical Department, University of Southern California.
- 11:40—"Motion Picture Showing Reduction of Fractures and the Removal of Foreign Bodies, Using Oil-Immersed Shock-Proof Units, Bi-Plane Fluoroscopic Control and Special Fracture Device," LEX G. MCCUTCHEN, M.D., St. Louis, Missouri. Radiologist, Firmin Desloge Hospital and St. Louis County Hospital.
- 12:00—"Further Observations on Spontaneous Multiple Symmetrical Fractures," L. A.

- MILKMAN, M.D., Scranton, Pennsylvania. Director of X-Ray Department Scranton State Hospital. Director X-Ray Department, Mercy Hospital; Professor Physics, St. Thomas College.
- 12:20—"Pelligrini-Srieda's Disease, Post-Traumatic Calcification of the Collateral Tibial Ligament of the Knee," MAX RITVO, M.D., Boston, Massachusetts. Roentgenologist, Boston City Hospital. Roentgenologist, Boston Bikur Cholim Hospital. Assistant Professor of Roentgenology, Tuft's Medical School. Instructor in Roentgenology, Harvard Medical School.
- 12:40—"Lead Poisoning in Infants and Children, with Special Reference to the Roentgenological Findings," EDWARD C. VOGT, M.D. Instructor in Roentgenology, Harvard Medical School; Roentgenologist, Infant's and Children's Hospital.
- CHARLES F. MCKHANN, M.D. Assistant Professor of Pediatrics, Harvard Medical School; Associate Physician, Infant's and Children's Hospital.
- 1:00—"Experimental and Clinical Studies of Pulmonary Abscess and Gangrene Following Tonsillectomy," ISADORE PILOT, M.D., Chicago, Illinois. Associate Professor of Medicine and Pathology, University of Illinois College of Medicine.

1:20—

1:40—

2:00 P.M. ADJOURNMENT

September 28, 1933

RED LACQUER ROOM THURSDAY, 9:00 A.M.

Section "B"

BREAST DISEASES

Presiding Officer, Dr. W. HERBERT MCGUFFIN, President, Radiological Society of North America

- 9:00—"Further Observations in Roentgen Diagnosis of the Breast," IRA H. LOCKWOOD, M.D., Kansas City, Missouri.
- 9:20—"Combined Surface and Interstitial Radiation in the Treatment of Mammary Cancer," ALBERT SOILAND, M.D., Los Angeles, California. Chairman, Maligancy Board of the California Hospital.
- 9:40—"A Method of Irradiating the Axilla with Special Reference to Mammary

Cancer," JAMES J. DUFFY, M.D., New York City. Assistant Attending Surgeon, Memorial Hospital.

CHARLES DE FOREST LUCAS, M.D., Clinical Research Fellow, Memorial Hospital.

10:00—"The Relative Value of Surgery, Radium and X-Ray Therapy in Carcinoma of the Breast," ISAAC LEVIN, M.D., New York City. Clinical Professor of Cancer Research, New York University.

10:20—"A Series of Carcinomas of the Breast Treated by Irradiation Alone Covering a Five Year Period," FRANK E. ADAIR, M.D., New York City.

10:40—"An Analysis of a Group of Primary Carcinomas of the Lungs, Treated with Deep X-Ray Therapy," WILLIS F. MANGES, M.D., Sc.D., Philadelphia, Pa. Professor of Roentgenology, Jefferson Medical College.

11:00 A.M. RECESS

11:20—"Technique and Results of Irradiation in Carcinoma of the Breast," GEORGE E. PFAHLER, M.D., Philadelphia, Pa. Professor of Radiology, Graduate School of Medicine, University of Pennsylvania.

JACOB H. VASTINE, M.D., Clinical Professor of Radiology, Woman's Medical College.

11:40—"The Treatment of Chest Wall Secondaries in Breast Carcinoma—A Preliminary Report of a New Radium Technique," GORDON E. RICHARDS, M.D., Toronto, Ontario. Associate Professor of Radiology, University of Toronto; Director, Ontario Government Institute of Radiotherapy; Director, Department of Radiology, Toronto General Hospital.

12:00—"The Treatment of 'Bleeding Nipple' by Means of Interstitial Radiation," MAX CUTLER, M.D., Chicago, Illinois. Director, Tumor Clinic, Michael Reese Hospital.

12:20—"Depth Doses of Roentgen Radiation, Striking at Angles Other Than Ninety Degrees, Measured in a Water Phantom," ERNST A. MAY, M.D., Newark, New Jersey. Director, Metcalf Foundation for Radiotherapy, Orange Memorial Hospital, Orange, New Jersey.

12:40—"Histopathology of Irradiated Hodgkin's

Disease and Lymphoblastoma," ALEXANDER BRUNSCHWIG, M.D., Chicago, Illinois. Department of Surgery and Division of Radiology, University of Chicago.

1:00—

1:20—

1:40—

2:00 P.M. ADJOURNMENT

September 29, 1933

GRAND BALL ROOM FRIDAY, 9:00 A.M.

Section "A"

UROLOGY, GYNECOLOGY AND MISCELLANEOUS

Presiding Officer, Dr. JOHN T. MURPHY, President, American Roentgen Ray Society

9:00—"Studies with Opaque Media in Urology," LEOPOLD JACHES, M.D., New York City. Radiologist, Mt. Sinai Hospital.

MOSES SWICK, B.S., M.D. Adjunct Surgeon, Mount Sinai Hospital; Attending Urologist, Harlem Hospital.

9:20—"Opaque Studies of the Uterus and Pelvis," DON CARLOS HEUSER, M.D., Buenos Aires, Argentine.

9:40—"Renal Peristalsis During Pyelonephritis: A Roentgenophysiologic Study," HANS A. JARRE, M.D., Detroit, Michigan. Attending Roentgenologist, Grace Hospital; Roentgenologist, Woman's Hospital and North End Clinic.

R. E. CUMMING, M.D.

10:00—"Further Observations in the Diagnosis of Tumors of the Kidney," BERNARD H. NICHOLS, M.D., Cleveland, Ohio. Director of Roentgenology, Cleveland Clinic.

10:20—"Roentgen Examination of the Chests of Five Hundred Newborn with Reference to Pathology Present Other Than Enlarged Thymus," LEON SOLIS-COHEN, M.D., Philadelphia, Pa. Radiologist, Jewish Hospital; Radiologist, Memorial Hospital.

SAMUEL BRUCK, M.D. Roentgenologist, Northern Liberties Hospital and Northeastern Hospital; Associate Roentgenologist, Jewish Hospital.

10:40—"A Radiological and Clinical Study of the Female Symphysis Pubis," JOHN M. BARNES, M.D., Buffalo, New York.

Roentgenologist, Millard Fillmore Hospital.

11:00 A.M. RECESS

- 11:20—"The Fate of Thorium Dioxide in the Body After Intravenous Injection," ERNST A. POHLE, M.D., Ph.D., Madison, Wisconsin. Professor of Radiology, University of Wisconsin.
GORTON RITCHIE, M.D. Assistant Professor of Radiology, University of Wisconsin.
- 11:40—"Animal Experiment with Colloidal Thorium, a Study in Lymphatic Absorption," (Lantern Slide Demonstration). R. POMERANZ, M.D., Newark, N. J. Associate Radiologist, Newark Beth Israel Hospital.
- 12:00—"Roentgen Studies on the Fate of Calcium in the Bones of Retained Dead Fetuses," An Evaluation of "Decalcification" as a Roentgenographic Diagnostic Criterion of Death of the Fetus in Utero. PAUL C. HODGES, Ph.D., M.D., Chicago, Illinois. Professor of Roentgenology, University of Chicago.
JOHN W. LAWLAH, M.S., M.D. Assistant Roentgenologist, Provident Hospital.
- 12:40—"Is the Antiquity of a Cell a Factor in Determining the Resistance to Radiation, and can we Imply Stimulating Doses of Radiation in Cancer Therapy?" ROBERT H. MILWEE, M.D., Dallas, Texas. Roentgenologist, The Dallas Methodist Hospital; Bradford Memorial Hospital for Children; Presbyterian Clinic; Radiation Therapist, City of Dallas Parkland Hospital.
- 12:20—"Methods of Standardization of Roentgenographic Technique," CHARLES WEYL, Philadelphia. Professor, Moore School of Electrical Engineering, Univ. of Pennsylvania.
- 1:00—"The Use of the Roentgen Rays in Science and Industry," C. A. POOLE, Covington, Kentucky. Director of Industrial Research, Kelley-Koett Mfg. Co., Inc.
- 1:20—"An Accurate Simple Method of Densitometric Analysis of Roentgenograms," HAROLD C. HODGE, M.D., Rochester, New York.
STAFFORD L. WARREN, M.D.
- 1:40—
- 2:00 P.M. ADJOURNMENT

September 29, 1933

RED LACQUER ROOM FRIDAY, 9:00 A.M.

Section "B"

UROLOGY AND GYNECOLOGY, AND ABDOMINAL DISEASES

Presiding Officer, Dr. ROLLIN H. STEVENS, President, American Radium Society

- 9:00—"The Radiation Treatment of Carcinoma of the Bladder," BENJAMIN S. BARRINGER, M.D., New York City. Attending Surgeon, Memorial Hospital; Attending Urologist, Fifth Avenue Hospital.
- 9:20—"Cancer of the Bladder—Methods of Treatment," CURTIS F. BURNAM, M.D., Baltimore, Maryland. Associate Professor of Surgery, Johns Hopkins Hospital; Radiologist, The Howard A. Kelly Hospital.
- 9:40—"Irradiation and Electrothermic Surgery in the Management of Carcinomata of the Urinary Bladder," J. THOMPSON STEVENS, M.D., Montclair, N. J. Director, Department for Study and Treatment of Neoplastic Diseases, Montclair Community Hospital, and St. Joseph's Hospital, Paterson, N. J.
- 10:00—"Radiation Treatment of Carcinoma of the Uterus," HENRY L. SCHMITZ, A.M., M.D., LL.D., Chicago, Illinois. Professor and Head of Department of Gynecology, Loyola University School of Medicine; Director, Mercy Hospital Institute of Radiation Therapy.
- 10:20—"The Treatment of Uterine Fibromas," LEDA J. STACY, M.D., Rochester, Minnesota.
- 10:40—"Radiation Treatment of Carcinoma of the Cervix," WILLIAM P. HEALY, M.D., New York City. Attending Surgeon, Department of Gynecology, Memorial Hospital.

11:00 A.M. RECESS

- 11:20—"Technic of Treatment of Cancer of Cervix with Radon," FRANK E. SIMPSON, M.D., Chicago, Illinois. Director of the Radium Clinic, American Hospital.
- 11:40—"Studies in the Diagnosis and Treatment of Teratoma Testis," RUSSELL S. FERGUSON, M.D., New York City. Assistant Surgeon, Memorial Hospital; Assistant in Clinical Surgery, Cornell University Medical College; Assistant Surgeon, New York Hospital.

12:00—"A Critical Study of the Use of the Lead Perforator and Reciprocal in Radiation Therapy," F. LIBERSON, M.D., New York City. Roentgenologist, U. S. Public Health Service Hospitals.

12:20—"Radium Treatment of Primary Carcinoma of the Rectum," HARRY H. BOWING, M.D., Rochester, Minnesota. Head of Section on Therapeutic Radiology (Radium)—Mayo Clinic; Assistant Professor of Radiology, Mayo Foundation for Medical Education and Research, Graduate School, University of Minnesota.

ROBERT E. FRICKE, M.D., Associate in Section on Therapeutic Radiology (Radium), Mayo Clinic; Instructor of Radiology, Mayo Foundation for Medical Education and Research, Graduate School, University of Minnesota.

12:40—"Abdominal Hodgkin's Disease," EDWARD L. JENKINSON, M.D., Chicago, Illinois. Director, Roentgen Department, St. Luke's Hospital and St. Joseph's Hosp.; Associate Professor, Roentgenology, Northwestern Medical College.

ARTHUR R. ELLIOTT, M.D., Clinical Professor of Medicine, Rush Medical College; Senior Attending Staff Medicine, St. Luke's Hospital.

1:00—"Palliative Irradiation of Carcinoma of the Stomach," GEORGE T. PACK, M.D., New York City.

1:20—"Postoperative Radiation in Carcinoma of the Ovary: Study of Twenty-Two Patients," (To be read by Title), JOHN T. FARRELL, JR., M.D., Philadelphia, Pa. Assistant Roentgenologist.

JOHN B. MONTGOMERY, M.D., Assistant in Gynecology, Jefferson Hospital.

1:40—"Some New Principles Regarding the Design of X-Ray Apparatus," ALBERT BOUWERS, M.D., Eindhoven, Holland.

2:00 P.M. ADJOURNMENT

September 29, 1933

GRAND BALL ROOM FRIDAY, 8:30 P.M.

Presentation of Medals and Honors by the Officers of the Radiological Society of North America:

President... W. HERBERT MCGUFFIN, M.D.

First Vice President

..... WILLIAM E. CHAMBERLAIN, M.D.

Second Vice President

..... W. WARNER WATKINS, M.D.

Third Vice President

..... HAROLD A. SPILMAN, M.D.

Secretary-Treasurer

..... DONALD S. CHILDS, M.D.

The Janeway Lecture—JAMES EWING, M.D., New York City, Professor of Pathology, Cornell University; Pathologist to Memorial Hospital.

Conducted by the Officers of the American Radium Society:

President..... ROLLIN H. STEVENS, M.D.

First Vice President

..... GEORGE W. GRIER, M.D.

Second Vice President

..... HOWARD MARROW, M.D.

Secretary..... WM. H. CAMERON, M.D.

Treasurer..... ZOE A. JOHNSTON, M.D.

September 30, 1933

GRAND BALL ROOM SATURDAY, 9:00 A.M.

Section "A"

NEUROLOGY AND MISCELLANEOUS

9:00—"Pituitary Tumors: Radiological Aspects of Diagnosis and Treatment," MERRILL C. SOSMAN, M.D., Boston, Massachusetts. Assistant Professor of Roentgenology, Harvard Medical School; Roentgenologist, Peter Bent Brigham Hospital; Associate in Roentgenology, Children's Hospital.

9:20—"Encephalography," KARL KORNBLUM, M.D., Philadelphia, Pa. Associate in Radiology, University of Pennsylvania. FRANCIS C. GRANT, M.D., Assistant Professor of Neuro-Surgery, School of Medicine, University of Pennsylvania; Associate in Surgery, School of Medicine, University of Pennsylvania; Associate in Neuro-Surgery, Graduate School of Medicine, University of Pennsylvania.

9:40—"Recent Advances in Encephalography," CORNELIUS G. DYKE, M.D., New York City. Assistant Director of X-Ray Department, Neurological Institute.

10:00—"Spinal Cord Lesions and Their Recognition by Roentgenologic Methods," JOHN D. CAMP, S.B., Ch.B., M.D., Rochester, Minnesota. Assistant Pro-

fessor of Radiology, University of Minnesota (Mayo Foundation); Associate in Section on Roentgenology, Mayo Clinic.

- 10:20—"The Normal Appearance of the Ventricles of the Brain, and the Displacements Caused by Temporal Lobe Tumors," A. H. PIRIE, M.D., Montreal, Quebec. Royal Victoria Hospital.

- 10:40—"Roentgenological Considerations of Sinus Diagnosis With and Without Radiopaque Oils," EDWIN C. ERNST, M.D., St. Louis, Missouri.

11:00 A.M. RECESS

- 11:20—"The Diagnosis of Accessory Sinuses," AMEDEE GRANGER, M.D., New Orleans, La. Professor of Radiology, Louisiana University Medical Center; Director of Department of Radiology, Charity Hospital.

- 11:40—"Roentgen Examination of the Mastoid Processes," FREDERICK M. LAW, M.D., New York City.

- 12:00—"The Scope and Technique of Soft Tissue Roentgenography," JOHN R. CARTY, M.D., New York City. Radiologist-in-Chief, New York Hospital; Associate Professor of Radiology, New York Hospital, Cornell Medical College Association.

- 12:20—"The Roentgenological Diagnosis of Intracardiac Calcifications," PAUL A. BISHOP, M.D., Philadelphia, Pa. Director, Department of Radiology, Pennsylvania Hospital.

- HUGO ROESLER, M.D., Associate Professor of Medicine and Roentgenology, Temple University.

- 12:40—(Title to be Sent In), MANUEL F. MADRAZO, M.D., Mexico City, Mexico. Roentgenologist, National R. R. of Mexico and Spanish Welfare Association; Executive Officer, Federal Health Department.

- 1:00—(Title to be Sent In), FILIBERTO RIVERO, M.D., Havana, Cuba. Head Professor of Radiology and Physiotherapy, Havana University; Director, Department of X-Ray and Physiotherapy, Mercedes Hospital; Vice Director, Juan Bruno Zayas, Department for Study and Treatment of Cancer.

- 1:20—"Further Observations on the Treatment of Pituitary Tumors," EDGAR W.

SPACKMAN, M.D., Philadelphia, Pa. Instructor in Radiology, Graduate School of Medicine, University of Pennsylvania.

- 1:40—"General Closing Session by the Officers of the Congress."

2:00 P.M. ADJOURNMENT

September 30, 1933

RED LACQUER ROOM SATURDAY, 9:00 A.M.

Section "B"

MISCELLANEOUS

Presiding Officer, Dr. JOHN T. MURPHY, President, American Roentgen Ray Society

- 9:00—"Experimental Studies of Portions of the Lymphatic System by Means of the Roentgen Ray," LEON J. MENVILLE, M.D., New Orleans, Louisiana. Assistant Professor, Medicine and Radiology, Tulane University of Louisiana School of Medicine.

J. N. ANE, M.D., Instructor in Medicine and Radiology, Tulane University of Louisiana School of Medicine.

- 9:20—"Pernicious Leucopenia," W. EDWARD CHAMBERLAIN, M.D., Philadelphia, Pa. Professor of Radiology, Temple University Medical School.

- 9:40—"Diagnosis and Roentgen Treatment of Parathyroid Dysfunction," EDWIN A. MERRITT, M.D., Washington, D. C. EDGAR M. McPEAK, M.D.

- 10:00—"Radium in the Treatment of Hyperthyroidism," ROLAND E. LOUCKS, M.D., Detroit, Michigan.

- 10:20—"Roentgen Treatment of Hyperthyroidism," THOMAS A. GROOVER, M.D., D.Sc., Washington, D. C.

ARTHUR CARLISLE CHRISTIE, M.S., M.D.

- 10:40—"Tuberculosis of the Larynx and Neck," (Lantern Slides), HENRY K. TAYLOR, M.D., New York City. Roentgenologist, Sea View Hospital.

LOUIS NATHANSON, M.D., Assistant Roentgenologist, Sea View Hospital.

11:00 A.M. RECESS

- 11:20—"A Report of 62 Cases of Herpes Zoster Treated with X-Rays," JOHN M. KEICHLIN, M.D., Huntingdon, Pa. Radiologist, J. C. Blair Memorial Hospital.

- 11:40—"Primary New Growths Involving the

- Hand,"* BERNARD F. SCHREINER, M.D., Buffalo, New York. WILLIAM H. WEHR, M.D.
- 12:00—"Some Phases in the Management of Myelogenous Leukemia," KENNETH D. A. ALLEN, M.D., Denver, Colorado; Roentgenologist, Presbyterian, Children's and Denver General Hospitals.
- 12:20—"Radiotherapy in Urticaria," (To be read by Representative), HUMBERTO H. CARELLI, M.D., Buenos Aires, Argentine.
- 12:40—"A Classification of Tumors from the Standpoint of Radiosensitivity," A. U. DESJARDINS, M.D., Rochester, Minnesota. Director, Division of Radiology, Mayo Clinic; Assistant Professor of Radiology, University of Minnesota.
- 1:00—"A Method to Render Radioresistant Tumors Radiosensitive," M. J. SITTENFELD, M.D., New York City.
- 1:20—
- 1:40—General Closing Session by the Officers of the Congress
- 2:00 P.M. ADJOURNMENT

NOTE—The effort will be made to carry out this program in the order arranged but circumstances may demand re-arrangement at the last moment.

NOTE—In order to carry out this program, it is essential that each speaker be limited to use not over twenty minutes which may include reading, remarks, and lantern slide demonstrations.

PROTECTION OF RADIOLOGY AS A SPECIALTY OF MEDICINE

To the Editor:

I am inclosing some information regarding the Pacific Roentgen Club which I hope you can publish in the *American Journal of Roentgenology and Radium Therapy*. I am also inclosing excerpt from resolutions of the Commonwealth Club.

HENRY SNURE

* * * * *

(1) At the April 25, 1933, meeting of the Commonwealth (San Francisco) Club of California the following matter was taken up: "The Public Health Section recommends that the Commonwealth Club endorse and support the following principles and program as the

most satisfactory approach to improved health organization in California.

I.

II. Recognition of the fact that medical service is composed of two distinct factors: (a) The personal, professional service of the physician and surgeon. (b) The ancillary forms of medical service such as hospitalization, nursing, laboratory procedures and x-ray.

III.

IV. That, since the expenses involving in the ancillary forms of health service are the more unpredictable and constitute the heavier burden, the insurance principle should be applied first to this type of service. This limitation of the insurance plan is recommended in order that it may be given a fair trial without being imperiled by the difficulties which might arise if, in the beginning, it were applied to the entire complex system of medical service.

V. That, since it is of fundamental importance that the physician be able to obtain all information necessary to diagnosis and since he is often unable to obtain this information because of the patient's inability to meet the expense involved in the performance of complete tests, *that various city, county and state health departments extend their activities to make available to the public at not to exceed cost, the ancillary forms of medical service of a preventive and diagnostic character.*"

These points were argued pro and con but no definite action was taken at the meeting in question.

* * * * *

California roentgenologists have banded themselves together to stand firmly upon their rights as practitioners of medicine. Aroused over the constant inroads upon their profession by laymen, nurses, corporations, and others not licensed in the healing art, the Californians have decided that the time is here for united protection and an aggressive offense against exploitation of their profession.

The organization is founded upon the principle that radiology is the practice of medicine and as such is due the full recognition of a learned and dignified branch of the profession. Threats of state medicine and an imminent move on the part of some powerful groups in California to ask that the state, counties and municipalities furn-

ish x-ray service at cost, led representatives of the profession to gather at Santa Maria on June 11 to form the Pacific Roentgen Club. Problems affecting Radiology in its relationship with other branches of medicine and with the general field of public health were thoroughly discussed at the session. Lowell S. Goin, M.D., of Los Angeles was named chairman of the club; L. H. Garland, M.D., of San Francisco, secretary, and these two, with Henry Snure, M.D., of Los Angeles, John Lawson, M.D., of Sacramento, and Robert Stone, M.D., of the University of California, form the executive committee. Roentgenologists considering a position on the West Coast are invited to communicate with the Pacific Roentgen Club. Any information that will help prevent exploitation or other unfair treatment will be cheerfully given.

"There have been constant inroads upon Radiology by laymen, nurses, corporations and others not scientifically trained in this highly important branch of medical practice," said a statement issued from the meeting. "We as Radiologists object to this for several reasons. First from the standpoint of public health. The X-ray is a potentially dangerous instrument, as is the scalpel of the surgeon, the hypodermic of morphia and the anesthetic. It is because these are in skillful and careful hands that they are of benefit to humanity—a thing equally true of the roentgen rays. The danger is not only one of physical damage to tissue (negligible in skilled hands), but the less spectacular and more commonly encountered danger resident in the absurd diagnoses by incompetent persons.

"We maintain that Radiology, being as it is, the diagnosis and treatment of human disease, is the practice of medicine, and as such, should be solely in the hands of those licensed to practice the healing art.

"We object to the exploitation of any physician for the gain of any non-medical concern. Under ruling of the California courts a corporation cannot engage in the practice of medicine. Nevertheless corporations do practice Radiology, which we maintain to be a part of the practice of medicine.

"X-ray diagnosis is one of the greatest advances that has been achieved in the practice of medicine. Radiation therapy combined with good surgery offers the only chance we know of today for the cure of malignant disease. If Radiology is degraded by falling into the hands of lay people and is forced down to the state where the Radiologist is merely the servant of a corporation, the high standards we have set up will fall and not only medicine but the general public will suffer a distinct loss.

"It is to prevent these things, and to stand firmly upon our rights as practitioners of medicine that we have organized. We propose to take such steps as may be necessary to prevent further inroads upon Radiology. We intend to maintain and improve our present standards and to have at all times the recognition due us as a learned and dignified branch of medicine. The California Medical Association has recognized this officially in Resolution No. 5 of the House of Delegates, adopted at the recent annual meeting and printed on page 465 of the June issue of *California and Western Medicine*."

The organization is being rapidly perfected and a program is now being mapped out to carry through the principles upon which it is founded.



DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., 105 Rutledge Ave., Charleston, S. C.

TECHNIQUE OF ROENTGEN EXAMINATION OF THE TEMPOROMANDIBULAR ARTICULATION

By JOHN SPROULL, M.D.

HAVERHILL, MASSACHUSETTS

FROM personal communication with many roentgenologists and roentgen technicians, I am convinced that but few

TECHNIQUE

Position of the Patient. The patient may lie either on the abdomen or the side to be examined. The cassette is placed on a 23° angle sinus board and the lateral aspect of the head corresponding to the joint to be examined is placed in a true lateral position on the cassette.

Position of the Tube. The tube is centered at a point 3 inches toward the vertex from the tragus which is uppermost; that is, if the right side is being examined, the

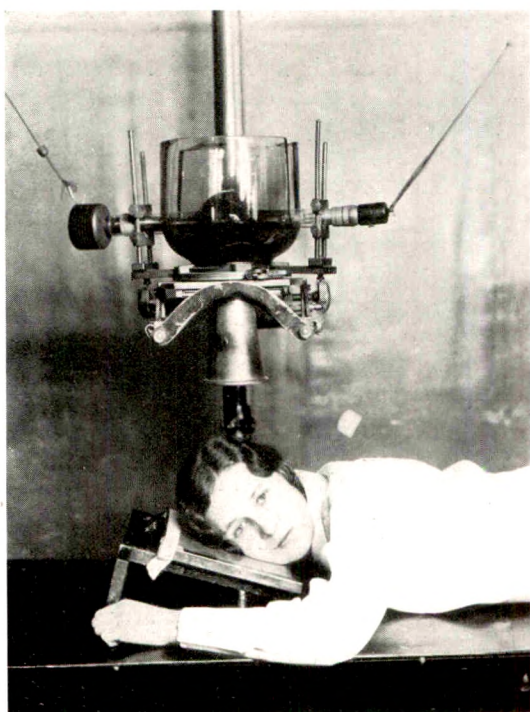


FIG. 1. Lateral view showing 23° angle sinus board, position of patient and the point of centering the tube.

possess a simple satisfactory technique for roentgen examination of the temporomandibular joint. No claim is made to priority for the method presented in this communication. Its development was brought about because of the difficulties and uncertainties encountered in the application of some other recommended methods.

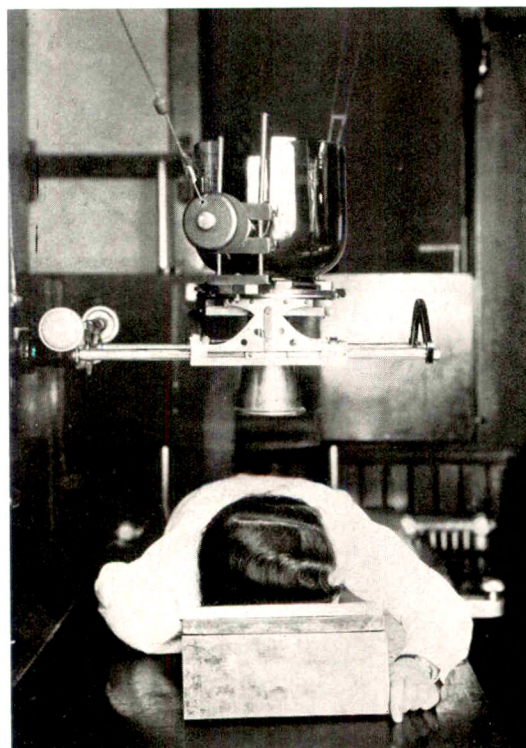


FIG. 2. Position of patient and tube seen in longitudinal direction.

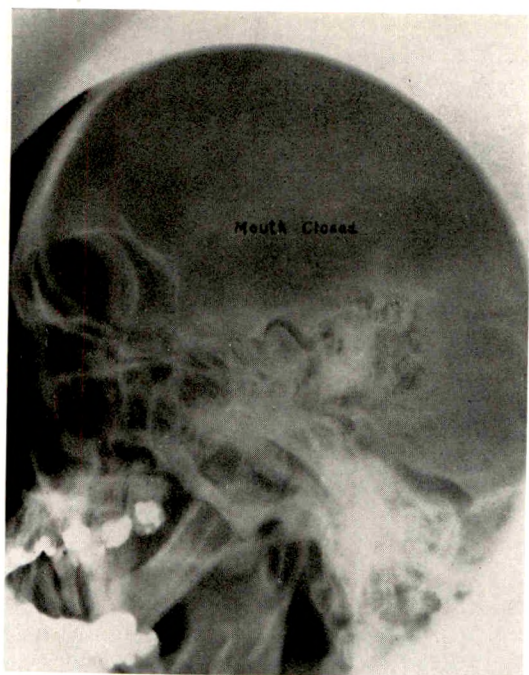


FIG. 3. View of temporomandibular articulation with mouth closed. Note the clear outline of the mandibular fossa and condyle. The joint space is well visualized.

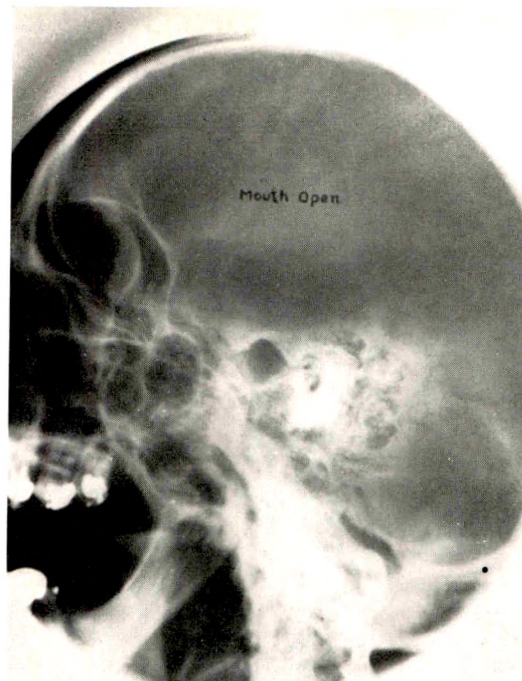


FIG. 4. View with mouth open. Note the clear visualization of the mandibular fossa, the eminentia articularis, and the articular surface of the condyle. Contrast with Figure 3 shows the range of normal mobility.

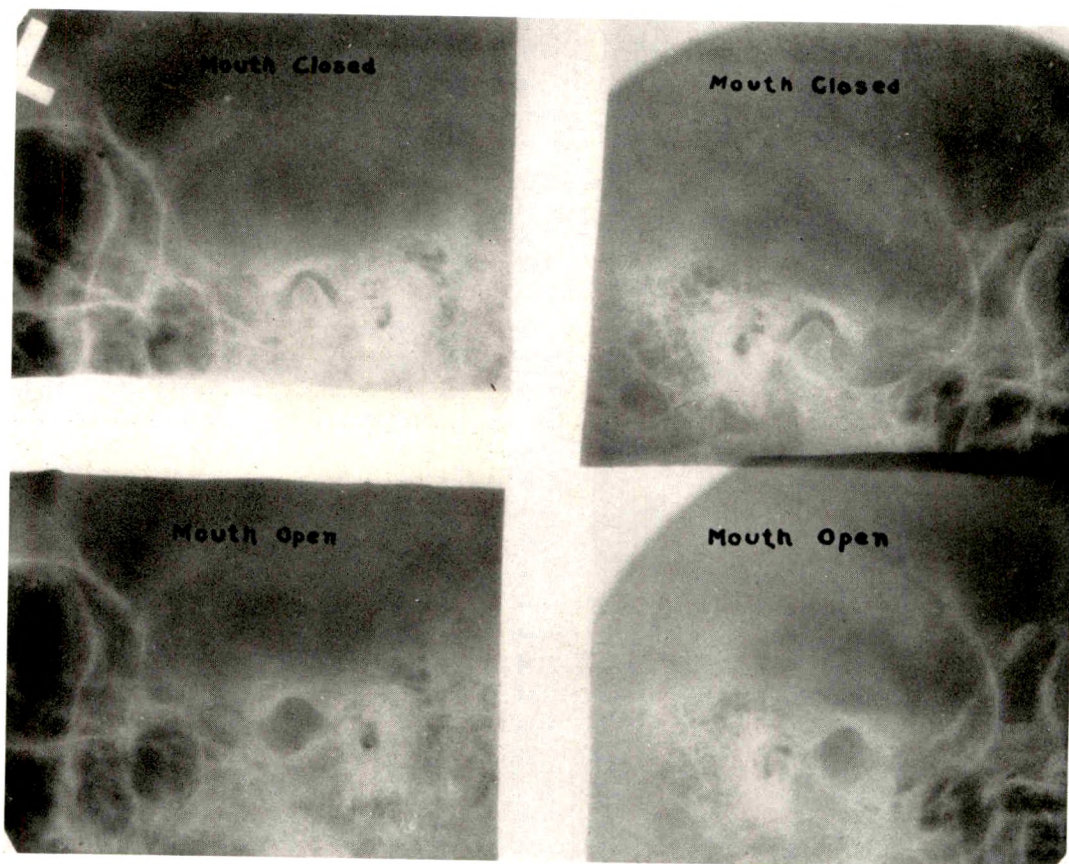


FIG. 5. Right and left mandibular joints of one patient taken with mouth open and closed; permits the comparison of one joint with the other.

tube is centered toward the vertex from the left tragus which is the uppermost in this position. No angulation of the tube is necessary (Figs. 1 and 2).

Two exposures should be made, one with the mouth closed and one with the mouth open. This procedure is recommended (Figs. 3 and 4). If desired, four exposures may be made on an 8" X 10" film. This permits the comparison of the appearances and mobility of one joint with the other (Fig. 5).

The method is simple and requires no great exercise of memory, and is satisfactory in that an excellent view is afforded of the width of the joint space, and details of the margins of the mandibular fossa and of the condyle of the mandible are clearly visualized. In addition, the method permits an estimate of the mobility of the articulation when alternate exposures are made with the mouth closed and open.



A NOMOGRAM AS AN AID IN THE DETERMINATION OF THE CUMULATIVE DOSE IN ROENTGEN AND RADIUM THERAPY*

By M. C. REINHARD and H. I. GOODALE
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WHEN radiation treatments are being carried on by means of roentgen rays or radium packs, it has been found expedient, both for the welfare of the patient and for the better effect on the tumor itself, to divide the treatments over a period

of several days or weeks. It becomes essential, therefore, to know the cumulative dose at any time during the course of treatment, so that the radiation may be discontinued when the tolerance limit of the skin is reached. It is of even greater importance

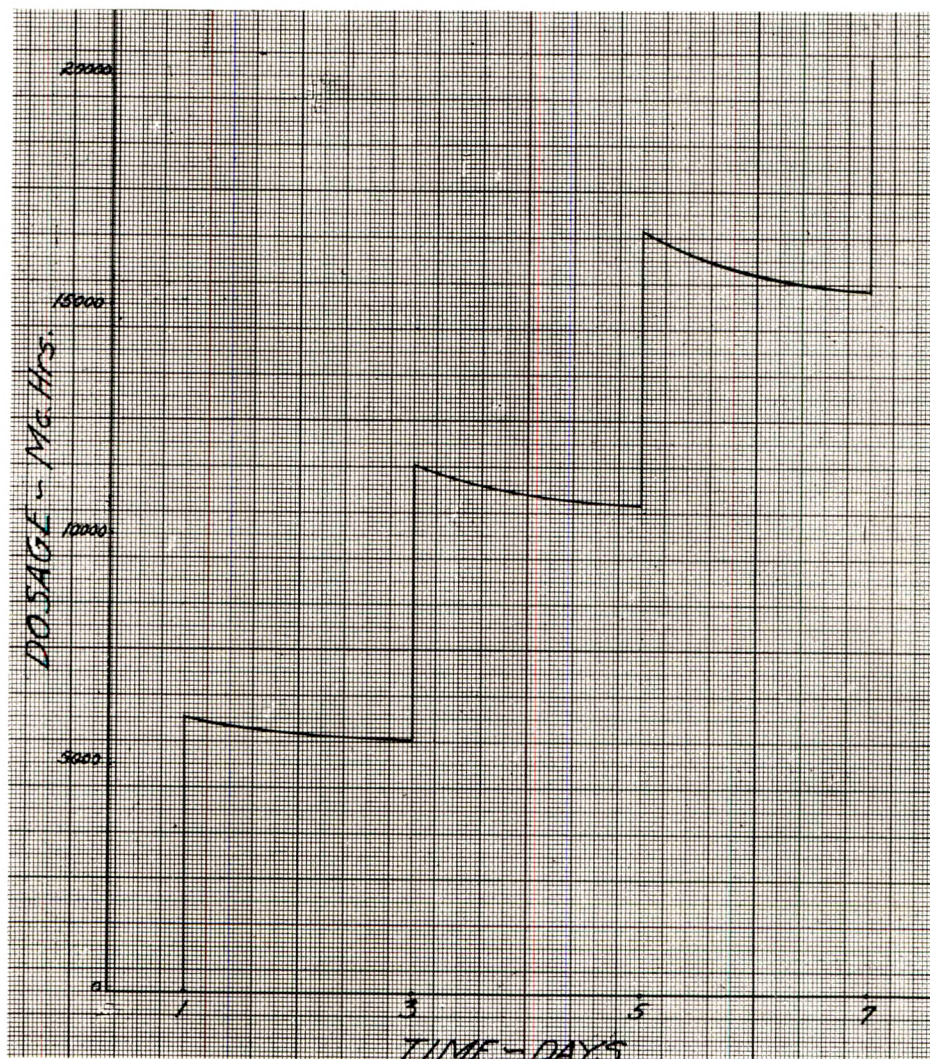


FIG. 1. Accumulation of radiation effect when 6,000 milligram-hours are given every second day.

* From the State Institute for the Study of Malignant Diseases, Buffalo, N. Y. (Burton T. Simpson, M.D., Director).

TABLE I
CUMULATIVE DOSAGE TABLES
TREATMENTS EVERY DAY

Daily Increment	3000	4000	5000	6000	8000	10000	15000
Days	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.
1	3000	4000	5000	6000	8000	10000	15000
2	5880	7842	9800	11760	15685	19608	29410
3	8655	11540	14415	17320	23060	28840	43270
4	11320	15070	18850	22640	30150	37700	56560
5	13880	18480	23110	27760	36960	46200	69320
6	16340	21750	27210	32680	43500	54400	81600
7	18700	24900	31140	37400	49800	62250	93400
8	20970	27420	34920	41950	55850	69800	104720
9	23150	30820	38550	46300	61680	76850	115600
10	25220	33620	42020	50500	67250	83950	126100
11	27250	36300	45400	54500	72610	90600	136100
12	29200	38890	48600	58380	77800	97000	145800
13	31050	41370	51680	62050	82750	103150	155000
14	32930	43730	54640	65650	87500	109100	163900
15	34600	46020	57500	69100	92030	114800	172400
16	36240	48220	60200	72400	96410	120300	180600
17	37800	50320	62800	75590	100620	125500	188500
18	39310	52320	65320	78600	104700	130500	196000
19	40790	54250	67720	81580	108500	135400	203300
20	42200	56150	70000	84400	112200	140000	210000

TREATMENTS EVERY SECOND DAY

Daily Increment	3000	4000	5000	6000	8000	10000	15000
Days	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.
1	3000	4000	5000	6000	8000	10000	15000
3	5770	7690	9615	11540	15380	19231	28850
5	8325	11100	13880	16650	22200	27750	41620
7	10680	14250	17810	21360	28500	35600	53400
9	12860	17150	21450	25700	34300	42870	64300
11	14870	19830	24800	29710	39670	49550	74350
13	16740	22300	27900	33420	44600	55720	83600
15	18450	24590	30750	36850	49180	61400	92150
17	20040	26690	33380	40000	53380	66650	100000
19	21500	28610	35800	42900	57200	71500	107310
21	22840	30410	38050	45600	60800	76000	114200
23	24080	32090	40100	48100	64150	80150	120500
25	25210	33600	42000	50400	67200	83960	126200
27	26290	35000	43800	52500	70000	87460	131500
29	27260	36300	45410	54050	72617	90700	136400
31	28160	37500	46900	55900	75000	93700	140900

TABLE I (Continued)
TREATMENTS EVERY THIRD DAY

Daily Increment	3000	4000	5000	6000	8000	10000	15000
Days	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.
1	3000	4000	5000	6000	8000	10000	15000
4	5660	7548	9435	11320	15100	18869	28300
7	8020	10700	13370	16040	21380	26800	40100
10	10118	13499	16850	20230	26950	33750	50570
13	11970	15970	19950	23950	31900	39930	59850
16	13620	18170	22700	27250	36300	45400	68200
19	15080	20120	25120	30180	40200	50250	75500
22	16380	21850	27300	32770	43650	54600	82000
25	17520	23380	29200	35070	46700	58400	87750
28	18540	24730	30900	37100	49420	61800	92800
31	19450	25930	32400	38900	51850	64900	97300
34	20250	27000	33730	40500	54000	67590	101300
37	20960	27950	34920	41920	55900	69940	104840
40	21570	28800	35970	43200	57600	72000	108200
43	22120	29550	36900	44300	59060	73840	111000

TREATMENTS EVERY FOURTH DAY

Daily Increment	3000	4000	5000	6000	8000	10000	15000
Days	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.
1	3000	4000	5000	6000	8000	10000	15000
5	5550	7409	9260	11115	14817	18521	27780
9	7730	10315	12890	15480	20620	25780	38680
13	9585	12790	15980	19200	25580	31950	47980
17	11170	14900	18620	22370	29790	37220	55850
21	12520	16700	20870	25070	33380	41720	62600
25	13660	18230	22780	27380	36430	45550	68380
29	14650	19540	24410	29320	39050	48800	73220
33	15480	20650	25800	31000	41270	51580	77410
37	16190	21600	27000	32420	43150	53910	81000
41	16800	22400	28000	33650	44750	55940	84000
45	17310	23090	28870	34700	46120	57660	86600
49	17750	23670	29600	35600	47300	59300	88800
53	18130	24170	30220	39500	48300	60550	90650

TREATMENTS EVERY FIFTH DAY

Daily Increment	3000	4000	5000	6000	8000	10000	15000
Days	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.	mg-hr.
1	3000	4000	5000	6000	8000	10000	15000
6	5456	7277	9093	10915	14550	18187	27280
11	7462	9960	12445	14940	19920	24890	37320
16	9110	12160	15190	18240	24310	30370	45550
21	10455	13960	17440	20940	27910	34870	52300
26	11560	15440	19270	23150	30850	38530	57800
31	12470	16650	20770	24960	33250	41550	62300
36	13210	17640	22000	26430	35220	44000	66000
41	13820	18450	23020	27670	36850	46030	69520
46	14320	19120	23860	28650	38170	47700	72270
51	14810	19660	24530	29460	39250	49070	74200
56	15130	20110	25100	30120	40150	50180	75800
61	15390	20480	25560	30680	40890	51080	77100

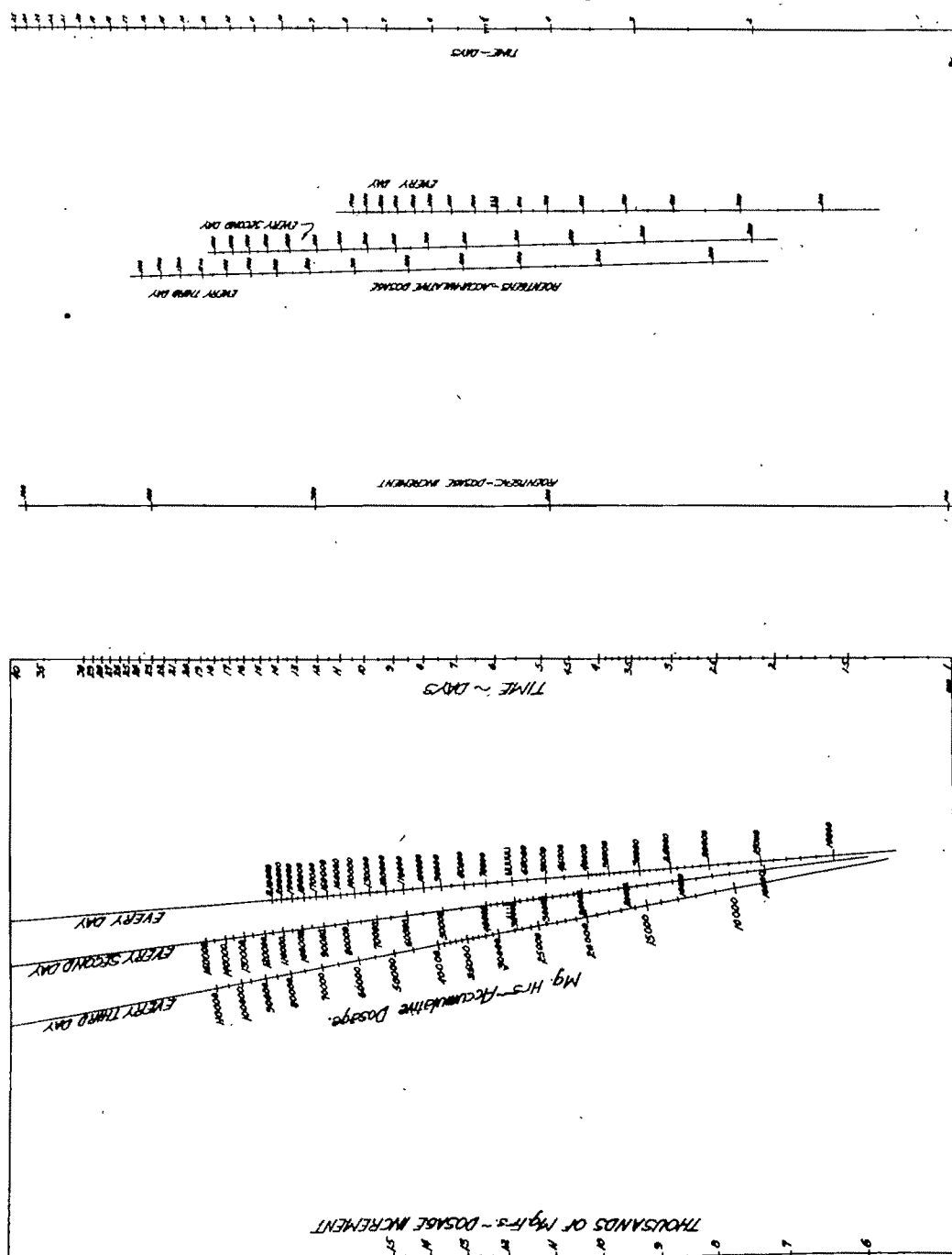


FIG. 2. Nomogram used in determining the cumulative dose from radium depending on dosage increments and time in days.

FIG. 3. Nomogram used in determining the cumulative dose from roentgen rays (λ effective 0.16 Å). This dosage is for air scattering only.

to know the cumulative dose each day, when internal irradiation or cross firing is resorted to.

Radium Packs. Using a loss of radiation effect of 4 per cent per day as used by Weatherwax¹ for radium filtered through 1 mm. of platinum, it is a simple matter to calculate the decrease of radiation effect by means of the equation $I_1 = I_0 e^{-\mu d}$ where, in this case μ is equal to 0.04. The other symbols have their usual significance as follows: I_1 = the final intensity; I_0 = the initial intensity; e is a constant = 2.718 and d is the time in days. However, when the treatments are divided as mentioned previously, the decrease in radiation effect is interrupted by successive additions so that the graph in Figure 1 represents a typical course of events during a series of treatments, when equal doses are given at regular intervals.

We have selected the peaks from curves of this type for time intervals of one, two, three, four and five days and for doses of 5,000 to 15,000 mg-hr. per treatment.

¹ Weatherwax, J. L. *Physics of Radiology*. Paul B. Hoeber, New York, 1931.

These data are assembled in Table 1. The values given are the cumulative dose on the particular day plus the additional radiation.

The information assembled in Table 1 may be expressed in a more practical way in the form of a nomogram as shown in Figure 2. From this nomogram, the dosage at any time may be obtained by placing a straight edge across the known values for dosage increment and time interval and the intersection of the straight edge with the center scale will show the cumulative dose. Or, if it is desired to know on what day a certain dosage is reached, the process may be reversed.

Roentgen Rays. Similarly for roentgen rays of effective wavelength 0.16 Å a nomogram (Fig. 3) has been constructed. In this case, however, the value of μ in the equation becomes 0.08 as determined by Stenstrom and Mattick². The dosage in this nomogram has been calculated in roentgens (air scattering only).

² Stenstrom, W., and Mattick, W. L. Study of skin reactions after divided roentgen-ray dosage. *AM. J. ROENTGENOL. & RADIOTHERAPY*, 1926, 15, 513-519.



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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

HAAS, LUDWIG. Über die nuchofrontale Aufnahme des Schädels. (On the nuchofrontal roentgenography of the skull.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1932, 45, 532-557.

The author, a few years ago, described the so-called nuchofrontal technique for examination of the skull in which the central ray is directed from the nape of the neck through the frontal region. The method differs from the usual occipitofrontal technique in that the central ray is more angulated, depending on the anatomic conditions. It has the advantages that it gives a very good visualization of the sella turcica and its surroundings, of the pyramidal bones, foramen magnum and its surroundings (jugular fossa, atlas, lateral part of the occipital bone), of the posterior cranial fossa, especially of the cerebellar fossa, of the inferior portion of the occipital bone, of the vertex of the skull (sagittal and coronary suture, parietal and frontal bones) and of the conditions of the cranial cavity (pineal body and ventricles in case of encephalography). The method must be considered as an adjunct to the usual procedures of examination. By a slight modification of the angulation a position similar to that used in Stenvers' technique is obtained. The article is profusely illustrated.—*T. Leucutia*.

STUHL, L., DAVID, M., and PUECH, P. Les méningiomes de la convexité du cerveau: étude radiologique. (Meningiomas of the convexity of the brain: roentgen study.) *J. de radiol. et d'électrol.*, Jan., 1932, 16, 5-23.

During the past three years the authors observed at the Pitié Hospital in Paris a total of 54 verified meningiomas, 21 of which were localized to the convexity of the brain. In these latter, roentgen signs were found in 16 cases that is, in 76 per cent (in 11 cases, that is, 52 per cent, the roentgen signs were detected preliminary to operation, whereas in 5 they were found only after operation).

The roentgen signs were dominated (A) by the osseous modifications due to extension of the tumor; (B) by osseous modifications secondary to hypervascularization, and (C) by calcifications within the tumor.

(A) According to Cushing the various types of osseous modifications due to extension of the tumor are represented by (1) thinning of the bone; (2) exostosis; (3) massive osteoma; (4) endostosis of the internal table; (5) invasion of the bone with hyperostosing reaction; (6) invasion with destruction, and (7) collar button-like meningioma with bone invasion. The authors themselves prefer to divide the osseous modifications due to invasion of the tumor as follows: (1) progressive thinning of the bone; (2) erosions; (3) osteogenic formations: (a) spicules and (b) hyperostosis.

(B) The osseous modifications secondary to hypervascularization are divided into (1) osseous straits and (2) vascular grooves.

(C) The calcifications represent a direct sign of the tumor but are observed only rarely. Their importance varies according to whether they infiltrate the entire extent of the tumor, leading to psammoma, or whether they are localized to parts of the tumor in the form of agglomerate opaque grains.

The article is illustrated with roentgenograms, photographs and reproductions of anatomic specimens. A bibliography of 23 references is appended.—*T. Leucutia*.

LÖW-BEER, ADALBERT. Intrakranielle Verkalkungen im Röntgenbilde. (Roentgen appearance of intracranial calcifications.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1932, 45, 420-449.

The author describes in this article (1) the physiologic intracranial calcifications which occur (a) in the glandula pinealis, (b) in the plexus chorioideus, (c) in the Pacchionian bodies, (d) in the falx cerebri, (e) in the tentorium cerebelli, and (2) the pathologic calcifications which occur (a) in the meninges and (b) in the brain substance proper.

The conclusions are reached that the roentgen demonstration of calcifications facilitates the direct localization of intracranial processes.

For the differentiation of pathologic from physiologic calcifications an exact knowledge of the normal site of the physiologic calcifications is necessary. The displacement of such calcifications often forms an indirect sign of localization of a pathologic process. The displacement of the calcification of the glandula pinealis and glomus chorioideum is often very difficult to estimate. The calcifications of the falx cerebri as a rule appear spindle-shaped, the semilunar type representing an indirect sign of localization. Meningeal calcifications are observed as a result of inflammatory processes or following intracranial hemorrhage or in meningeal tumors. In chronic otitis media a calcification of the dura above the tegmen tympani forming a sort of "encapsulated perforation," is not infrequently found. The roentgen examination only rarely permits a differentiation between a benign and a malignant meningeal tumor. The slow growth does not necessarily indicate histologic homoiotypia. Intracerebral calcifications are sequelae of specific and non-specific inflammations, hemorrhages, parasites and tumors. Craniopharyngiomas show a rather typical arrangement of the calcium deposit, permitting a differentiation on the roentgen appearance alone. The size of the calcium focus does not permit any conclusions concerning the size of an intracranial tumor.—*T. Leucutia*.

MORQUIO, L. L'hémiplégie du kyste hydatique cérébral chez l'enfant. (Hemiplegia of cerebral hydatid cyst in children.) *Rev. sud-am. de méd. et de chir.*, Jan., 1932, 3, 39-58.

Five cases of cerebral hydatid cyst leading to typical hemiplegia were observed in children. The 5 cases are described in detail and illustrated with roentgenograms and one pathologic specimen. The elements characterizing the syndrome of hemiplegia are as follows: (1) The hemiplegia is nearly always complete, there being a participation of upper and lower extremity and in a few instances paralysis of the inferior facial. In right-sided hemiplegias aphasia or alterations of speech which, as a rule, subside after operation may also be encountered. The hemiplegia is spastic, there being hypertonicity, exaggeration of the reflexes, clonus of the foot, epileptoid trepidation, Babinski sign, etc. In 3 out of the 5 observations it has developed in two times with various intervals. (2) The hemiplegia is, as a rule, complicated with loss of equilibrium, faulty motor coordination, etc. (3) The cranium pre-

sents irregularities on palpation, with areas of bone softening which are very tender to manipulation. The roentgenograms reveal a separation of the sutures with bony rarefaction, impressiones digitatae and occasional enlargement or complete destruction of the sella turcica. (4) The ophthalmoscopic examination shows invariably the presence of choked discs; indicating a progressive evolution of the process. Of the 5 cases 4 were operated on, resulting in 2 deaths and 2 cures. An early diagnosis is very important.—*T. Leucutia*.

RIGBY, R. A. C. An intracranial dermoid cyst. *Brit. J. Radiol.*, April, 1932, 5, 349-350.

The author briefly describes, using three roentgenograms for illustration, a case of intracranial dermoid cyst occurring in a male aged two and a half years. The unusual feature was the presence of numerous teeth in the neighborhood of the sella turcica and more posteriorly, and a shadow suggesting the outline of the cyst. No record can be found in the literature of an intracranial dermoid having been shown roentgenologically.—*T. Leucutia*.

BERNARD, P.-M., and SOURICE. Utilisation du "déplacement" ou méthode de Proetz pour l'exploration des sinus du crane. (Utilization of the "displacement" or Proetz method for the exploration of the sinuses of the cranium.) *Bull. et mém. Soc. de radiol. méd. de France*, Nov., 1931, 19, 454-457.

In 1928 Proetz published a new method for the diagnosis and treatment of sinusitis. His experiments were made in association with Le Mée who at that time was sent on a mission to the United States. Returning to France, Le Mée continued the work along the same line and recently, together with Bouchet, made a communication to the Annual Congress of the Society of Laryngology on the subject. The authors, being associated with this work, wish now to report the technique which is employed in France. Proetz, as is known, has since then written a book on the subject and Le Mée will shortly publish a monograph.

The principle of the method is as follows: Instead of introducing the radiopaque substance into the sinuses by means of an instrument such as a trocar or sound, as practiced heretofore, this is accomplished by displacing the air of the sinuses with the opaque substance by means of a negative pressure. The opaque substance is first instilled into one nasal

fossa and then the negative pressure is produced by intermittently obliterating one nostril and applying a source of aspiration (water bulb, air bulb, motor pump, etc.) to the other. Due to the modification of the pressure within the nasal cavity, the sinuses fill automatically, each air bubble being displaced by a like drop of the opaque substance—whence the name of “displacement” method. As can be seen, the state of the ostium is of paramount importance. If all the necessary precautions are taken, every sinus which does not permit the passage of the opaque substance may be considered pathologic. The time elapsing between the introduction of the fluid and its disappearance is, on an average, seventy-two hours, which therefore must be considered as the normal time of evacuation.

Three conditions are essential for the examination to be successful: (1) all sinuses must be visible on the films; (2) they must be projected in their entirety in the three dimensions, and (3) the position of the tube, film and patient must remain mathematically fixed, that is, must remain unchanged for a given incidence at all examinations.

Various apparatus were constructed embodying these principles (Ernst, Allen, Baum). The authors use four incidences, the horizontal ray passing each time through the base line which unites the nasofrontal suture with the external auditory meatus (the patient being in a sitting position and the tube tilted horizontally): (1) suprainial incidence for the frontal and ethmoidal sinuses; (2) infrainial incidence for the maxillary sinuses (same incidence, except that the mouth is kept wide open, being used for the base of the sphenoid sinus); (3) lateral incidence with the head at 90° rotation, the base line remaining horizontal, and (4) submental-vertical (ground plane) incidence, the base line being vertical (head inclined backward) and the horizontal ray being centered underneath the chin.

According to Le Mée and Bouchet, the method has the following advantages: (1) it makes use of the weight of the fluid which penetrates into all cells regardless of their normal or abnormal situation; (2) the introduction of the fluid is obtained without instruments, that is, without traumatism or secondary reaction; (3) the introduction is general, permitting a comparison of the two sides; (4) an easy distinction can be made between the so-called medical and surgical cases; (5) the method may

be used both for diagnostic and therapeutic purposes.—*T. Leucuria.*

SOURCE. Présentation d'un appareil permettant l'exploration radiologique des sinus du crâne préalablement remplis de liquide opaque (Méthode de Proetz). (Presentation of an apparatus permitting roentgen exploration of the sinuses of the cranium preliminarily filled with opaque liquid—method of Proetz.) *Bull. et mém. Soc. de radiol. méd. de France.*, Dec., 1931, 19, 494-497.

The author in this article describes a special apparatus which was constructed by Massiot for the roentgenography of the accessory sinuses of the skull according to the Proetz method (see above abstract). Similar apparatus were constructed by Ernst, Allen and Baum.

The apparatus has certain new features. Thus, it is composed of two statives, one for the support of the tube and the other for the support of the screen. This latter is used for exact centering and is replaced by the film cassette when the roentgenogram is made. The tube can be angulated to any of the desired positions and strictly immobilized. The apparatus is described in detail and illustrated with a photograph.—*T. Leucuria.*

LE MÉE, J.-M., and BOUCHET, M. La méthode de “déplacement” ou de Proetz dans le diagnostic et le traitement des sinusites. (The “displacement” or Proetz method in the diagnosis and treatment of sinusitis.) *Presse méd.*, March 12, 1932, 40, 394-396.

The so-called “displacement” method consists in substituting the normal air of the sinuses with a fluid which might be a drug in case of therapy or a radiopaque substance in case of diagnostic procedure. This indicates that the method might be used (1) for therapeutic considerations and (2) for diagnostic purposes. Proetz, in 1925, elaborated the diagnostic procedures and after perfecting the technique, he has now established a standard method.

The authors describe in detail (1) the principles of the method; (2) the technique, such as preparation of the patient, instrumentation, position during roentgen examination, roentgen apparatus, etc.; (3) the interpretation of the results obtained, such as diagnosis of sinusitis, the importance of the state of the ostium and of the time of evacuation, and (4) the therapeutic utilization. They conclude as fol-

lows: The method of Proetz presents a certain number of advantages: (1) it is neither painful nor injurious, the only foreign body introduced within the nasal cavity being a fluid which penetrates into the sinuses by gravity; (2) all sinuses are injected, this permitting the detection of aberrant cells which are often the seat of origin of pathological processes; (3) the introduction of the opaque substance is general, this making possible the comparison of all sinuses of one or both sides; (4) it is a method which simplifies the lipiodol diagnosis of paranasal cavities and completes it by the study of the time of evacuation; (5) it permits a rapid separation of medical and surgical cases, thus forestalling unnecessary or uncomfortable operations. Every sinus which fills is to be treated medically, while those which despite the necessary precautions show non-filling should be treated surgically; (6) it conforms to the modern ideas tending to supplement the clinical examination with a system of functional and graphic tests; it therefore represents for the sinuses what tetraiodophenolphthalein does for the biliary tract or uroselectan for the renal system; (7) from the therapeutic standpoint it respects the ostium which according to the anatomists represents the most important vascular nervous point dominating the entire pathology of the sinuses; (8) it represents a logical therapeutic procedure of sinus infections inasmuch as it acts directly on the mucosa.—*T. Leucutia*.

NECK AND CHEST

HEUSER, CARLOS. L'arteriographie. (Arteriography.) *Bull. et mém. Soc. de radiol. méd. de France*, May, 1932, 20, 284-291.

The author performed a series of experiments on rabbits, dogs and monkeys, for the visualization of the arterial system by injecting lithium carmine and isamine blue, in conjunction with colloidal thorium. The lithium carmine was found to be very toxic and was therefore abandoned. The isamine blue gave quite satisfactory results although this preparation has the inconvenience that it is decomposed above 80° and therefore it cannot be sterilized by boiling. The remarkable fact was that neither the colloidal thorium nor the isamine blue produced satisfactory shadows when injected separately but they gave the desired result when injected together. In this manner not only a good visualization of the blood vessels but a very intense impregnation of the liver

and spleen was obtained with a rather small dose within a short period (8 hours). The method also gave very good visualization of the descending aorta. As stated above its only disadvantage is that the isamine blue is decomposed by heat and therefore the solution must be always prepared fresh, a procedure which is somewhat cumbersome. The technique is as follows: first day, intravenous injection of 2 c.c. of isamine blue on an empty stomach; second day, injection of 25 c.c. thorotrast and immediately afterwards of 2 c.c. isamine blue. Ten hours later a first roentgenogram of the liver is made; third day, rest; fourth day, second injection of 25 c.c. thorotrast and immediately afterwards of 2 c.c. isamine blue. Following this second injection a roentgen visualization of the pulmonary arteries and descending aorta is obtained.

By using the above-described method the author was able to obtain hepatolienography, arteriography and impregnation of the vessels in the human without any danger. Although during the few months that the method has been employed no inconveniences have been observed, the author does not wish as yet to affirm that the method is entirely harmless.—*T. Leucutia*.

RAVINA and SOURICE. Étude expérimentale de l'artériographie pulmonaire. (Experimental study of pulmonary arteriography.) *Bull. et mém. Soc. de radiol. méd. de France*, March, 1932, 20, 129-132.

The authors carried out a series of experiments on dogs by injecting the pulmonary arteries through a sound which was introduced through the internal jugular vein directly into the right ventricle of the heart. The material first used was sodium iodide in a 30 to 70 per cent concentration, and abrodil and tenebril later. It was found that the best opacity is obtained from the sodium iodide. Because of the danger connected with embolism the method, at least for the time being, has to remain purely experimental.—*T. Leucutia*.

CREMER, VALENTINE. Volumineux kyste gazeux congénital du poumon chez un enfant. (Voluminous air cyst of the lung in a child.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1932, 20, 203-205.

Cases of voluminous congenital air cysts of the lung are exceedingly rare. A review of the literature hardly reveals 30 cases. The author

had the opportunity to observe such a case in a boy fifteen years of age, the cyst having occupied practically the entire right hemithorax. It is interesting that the condition was first diagnosed as a spontaneous pneumothorax. The diagnosis of air cyst was made from the fact that the lower border of the cyst was well demonstrated and that the cardiovascular and hilar shadows were displaced towards the opposite side, in a manner suggesting pressure from a rounded cyst.

It is only exceptional that such cases attain the ages of fifteen to twenty years, the majority succumbing to intercurrent grip or bronchopulmonary infection.—*T. Leucutia.*

MELLER, OSCAR. Câte-va tipuri de reacțiune perifocală în adenopatia tuberculoasă la copil. (Certain types of perifocal reaction in tuberculous adenopathy in children.) *Bul. soc. de radiol. și electrol. med. din România*, March, 1932, 1, 5-9.

The author, on the basis of clinical and autopsy material, wishes to draw attention to the so-called perifocal reaction around tuberculous hilar glands in children. In its simplest form, this reaction appears as an accentuation of the alveolar or polygonal markings around the hilus and may be irreversible or reversible. In the first case, the substratum is formed by an interlobar fibrous connective tissue, whereas in the second it is the result of an edema. Experimental investigations carried out by the author in association with Menkes proved beyond doubt that interlobar connective tissue when saturated with water becomes roentgenologically visible. In a more advanced form, the reaction appears as a homogeneous shadow within the pulmonary field extending from the hilus towards the periphery and occasionally involving an entire lobe. The evolution in most instances is benign, a *restitutio ad integrum* resulting. In one of the cases it took nearly fourteen months before the resorption became complete, indicating that the reaction might last for a long period.

The differential diagnosis includes a primary lesion, early parenchymal infiltration, hilar pneumonia, etc.

The reaction may also occur within the glandular mass or along the interlobar septa. In the first, a more or less temporary tumefaction of the involved glands, in the second, a so-called fibrous scissuritis or even an interlobar collection of fluid may result.—*T. Leucutia.*

THOYER-ROZAT, P., and DELHERM, L. Du rôle social du radiodiagnostic dans le dépistage de la tuberculose pulmonaire. (The social rôle of roentgen diagnosis in detection of pulmonary tuberculosis.) *J. de radiol. et d'électrol.*, March, 1932, 16, 111-113.

The authors advise that periodic roentgen examinations of the chest be made at various ages and occasions to detect unsuspected early tuberculous lesions. Thus they believe that these examinations could be performed (1) in school children once a year when admitted to the next grade; (2) in adolescence when admitted to the various schools of specialty (nursing schools, universities, etc.); (3) in adults when admitted to the military service, when obtaining a marriage certificate or when applying for life insurance, driver's license, or asking admittance to various enterprises (banks, railroads, mines, etc.).—*T. Leucutia.*

MURDOCH, J. Diagnostic radiologique des tumeurs pulmonaires. (Roentgen diagnosis of pulmonary tumors.) *Cancer, Brux.*, 1931, 8, 150-160.

Whereas in the second half of the last century only 5 per cent of pulmonary tumors could be diagnosed during life, the percentage has now increased to over 50, thanks to the contribution of the roentgen method.

I. Primary tumors of the lung. (1) Pulmonary carcinoma (bronchial carcinoma). A. Direct signs. These consist in the demonstration of the roentgen shadow corresponding to the actual tumor. The author differentiates (a) an intra-bronchial stage; (b) cancerous pneumonia; (c) hilar carcinoma; (d) lobar carcinoma; (e) cancerous lymphangitis, and (f) intralobar nodular carcinoma, the appearances being described in detail for all these forms. B. Secondary signs. (a) Bronchial stenosis by the obstructing neoplasm which may lead to mediastinal, diaphragmatic and pulmonary phenomena. The mediastinal phenomenon consists in displacement of the mediastinal shadow towards the diseased side, a pendulum-like migration being not infrequently observed at the roentgenoscopic examination. It is necessary, however, that the bronchial lumen be reduced at least one-third of the normal diameter. The diaphragmatic phenomenon consists in elevation of the diaphragm leaf and limited excursion. According to Lenk, the changes of the diaphragm are due to paralysis of the phrenic nerve from metastatic compression rather

than to bronchial stenosis. The pulmonary phenomenon consists in compensatory emphysema which is occasionally associated with a curious valve-like action, the air being able to enter the portion of the lung distal to the obstruction but being unable to leave because of complete obstruction produced by the partly-movable tumor. (b) Pulmonary metastases. Secondary metastases within the lung parenchyma from a primary bronchogenic carcinoma are not altogether rare. (c) Pleural effusion. This is observed in the more advanced cases and it may occur either freely in the pleural cavity or may be encysted or, finally, may be interlobar. (2) Pulmonary sarcoma. This condition is so rare that several authors deny its existence. The roentgen appearance shows great analogy to that of carcinoma. (3) Lymphogranulomatosis which may have a miliary and nodular form, primary leucemia, benign tumors and cysts are conditions which give a more or less characteristic picture.

II. Secondary tumors of the lung. These are classified as (1) secondary metastatic lymphangitis; (2) miliary metastases; (3) solitary nodular metastases; (4) multiple nodular metastases, and (5) irregular metastases.

III. Auxiliary methods of examination. These consist in bronchography, pneumothorax and the so-called therapeutic test dose.—*T. Leucutia*.

CANIGIANI, TH. Zur Röntgendiagnostik des Aneurysma dissecans der Brustaorta. (Roentgen diagnosis of dissecting aneurysm of the thoracic aorta.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1932, 45, 416-420.

Two cases of dissecting aneurysm of the thoracic aorta, which were examined roentgenologically, are briefly described and discussed in view of the autopsy findings. One of the cases represented a circumscribed aneurysma dissecans sacciforme and the other a diffuse cylindrical aneurysm. Concerning the roentgen appearance, the author expresses the opinion that the diffuse cylindrical dissecting aneurysm is recognized only rarely, whereas the sacciform type is recognized more frequently because of calcium deposit in the wall or because of the type of pulsation of the shadow seen roentgenoscopically. Differential diagnosis includes mediastinal tumors, dermoid cysts, intrathoracic struma, carcinoma of the hilus, neurogenic tumors and occasionally esophageal carcinoma.—*T. Leucutia*.

BOLLER, R., and PAPE, R. Zur Diagnose des Herzaneurysmas. (Diagnosis of aneurysms of the heart.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1932, 45, 318-327.

The authors describe a case in which a clinical diagnosis of luetic insufficiency of the aorta was made but which on roentgen examination showed a marked enlargement of the right border of the heart, suggesting because of its atypical appearance the possibility of an aneurysm. Post-mortem examination confirmed the roentgen diagnosis, except for the fact that the aneurysm was located to the ventricular septum, which was displaced to the right, producing a secondary displacement of the right border of the heart from pressure. In addition, there was mesaortitis with aortic insufficiency and coronary sclerosis. The most interesting feature of the case, however, was that there was no dilatation of the right ventricle itself.

In connection with this case, the author discusses the positive roentgen signs of cardiac aneurysm which result from changes in (1) position, (2) size and form, (3) pulsation and (4) secondary manifestations brought about by the growing aneurysm. These signs are encountered (1) in aneurysms with contour formation, (2) in aneurysm of the septum, (3) in intracardiac aneurysms localized to the sinus valsalvae and (4) in aneurysms with calcified parietal thrombi. (5) In doubtful cases the presence of coronary sclerosis may help to substantiate the diagnosis.—*T. Leucutia*.

ROUTIER, DANIEL, and HEIM DE BALSAC, R. Aspects radiologiques du coeur dans les endocardites mitrales rhumatismales. (Roentgen aspects of the heart in rheumatic mitral endocarditis.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1932, 20, 197-200.

For the past fifteen years cardiologists paid attention chiefly to the mechanical conditions created by the valvular lesions. Thus they considered the cardiopathies as entirely dominated by the intracardiac hydraulic disorders developing secondary to the valvular strictures and resulting in hypertrophy, later dilatation and insufficiency. This conception directed the roentgen investigator toward the detection of signs which would permit the clinician to affirm the valvular lesion and to make a differentiation between insufficiency and stenosis, which appeared to be of paramount importance. At the present time the theory of stabilized or evolutive inflammatory process has practically re-

placed the purely mechanical conception. According to this, the inflammation extends, in addition to the valves, to the adjoining myocardium and occasionally to the pericardium. Because of the changes produced within the muscle the mechanical causes are permitted to act on the walls, thus producing dilatation with certain well-defined deformities of the contours of the cardiovascular shadow. In viewing the problem thus, the rheumatic mitral endocardites form a homogeneous nosologic group which includes the old subdivisions of stenosis, insufficiency or mitral disease. The myocardial alterations being localized nearly always to the same region of the heart, especially to the left auricle, the roentgen deformities present a more uniform aspect. The authors insist chiefly on two signs which are of great value: (1) the prominence of the left auricle as viewed in the transverse position and (2) the venous stasis at the hilus and roots of the lungs as viewed in the posteroanterior position.—*T. Leucutia*.

ROUTIER and HEIM DE BALSAC. Aspects radiologiques du cœur dans les endocardites mitrales rhumatismales. (Roentgen aspects of the heart in rheumatic mitral endocardites.) *Bull. et mém. Soc. de radiol. méd. de France*, May, 1932, 20, 271-276.

In this second communication, the authors present cases of rheumatic mitral endocarditis which, because of the lack of inflammatory involvement of the myocardium, failed to produce roentgen deformities of the cardiac shadow. The auscultative findings were identical with those of the cases presented in the first communication but the heart appeared of normal volume or only slightly enlarged in size. Although occasionally there was a slight elongation of the median arc in the posteroanterior view, this did not increase in the right anterior oblique rotation. Likewise the left auricle did not protrude into the retrocardiac space and there was no evidence of venous stasis at the hilus.

The conclusion is drawn from these two communications (1) that a roentgen silhouette which is characteristic of a definite mitral valvular lesion does not exist; (2) that a roentgen examination cannot and should not establish a diagnosis of a valvular lesion, and (3) that the myocardial reaction is the factor chiefly responsible for the form and volume of the heart. In this manner, the roentgen examination, although often in disagreement with the

physical signs, is, as a rule—but not always—in harmony with the cardiovascular functional disorders.—*T. Leucutia*.

COSSIO, PEDRO. L'image radiographique de la fibrillation auriculaire. (Roentgenographic image of auricular fibrillation.) *Rev. sud-am. de méd. et de chir.*, Jan., 1932, 3, 19-28.

On the basis of 15 personal observations (one of which was controlled at autopsy), the author describes a typical roentgen picture of auricular fibrillation which is as follows: There is a mitral configuration of the left contour of the heart associated with a double arc of the right contour. The mitral configuration consists in an exaggeration of the median arc with a lowering of point G as compared to point D; the double arc is the result of the projection of the enlarged left auricle representing the superior arc and of the projection of the right ventricle representing the inferior arc.

Dilatation of the auricles is a rather common finding in the autopsies of all individuals who during life presented an auricular fibrillation. Conversely, one may assume that whenever there is a marked auricular dilatation and whenever the above typical roentgen image is encountered, one may assume the presence of auricular fibrillation. In the author's cases this was confirmed in every instance by electrocardiography. This of course does not indicate that all cases of auricular fibrillation give the above said typical roentgen picture since many of the auricular fibrillations are not associated with dilatation of the auricles. But one can affirm with certainty that whenever the dilatation of the left auricle oversteps the right contour of the cardiac silhouette producing the second arc above that of the right ventricle an auricular fibrillation may be diagnosed.—*T. Leucutia*.

HARET and FRAIN. A propos de l'examen radiologique du cœur (étude quantitative). (Concerning the roentgen examination of the heart; quantitative study.) *Bull. et mém. Soc. de radiol. méd. de France*, Jan., 1932, 20, 35-39.

In studying the diameters of the heart as measured on the cardiac silhouette, one must take into consideration that the distance of the plane of the greatest diameters from the plane of the film (in the posteroanterior view) varies for every individual, and that the average distance which is taken in the routine examination

carries a greater or lesser degree of error. The author, aiming to obtain the exact value of the diameters of the heart as measured in teleroentgenograms, corrected the above error by introducing the so-called "index of correction." This is determined by first roentgenoscopically marking point G (in the exact posteroanterior position) with an opaque landmark and by estimating the difference of the displacement of the end of the greatest diameter when two exposures are made on the same film, the tube being moved for a certain distance (1 cm. for every 10 cm. focus film distance) parallel with the plane of the film. The formula of the index of correction thus obtained is $d/d+a$ in which d represents the distance of focus displacement and a the distance displacement of the end of the greatest diameter. The method is very similar to that used for the localization of foreign bodies.—*T. Leucutia.*

GIANNELLI, V. Ricerche radiologiche sul volume del cuore e sull'indice cardiaco individuale nei bambini dai 6 ai 12 anni. (Roentgen research on the volume of the heart and individual cardiac index in children from six to twelve years.) *Diario radiol., Torino*, Nov.-Dec., 1931, 10, 161-178.

The methods employed for determination of the volume of the heart may be roughly divided into two divisions: (1) those which make use of the orthodiagram and teleroentgenogram by basing the measurements on various landmarks of the border of the heart or on the calculation of the surface area of the frontal section, and (2) those which approximate the heart to certain well-known geometrical configurations and estimate the volumetric dimensions by mathematical calculation. To this latter group belongs the method of Salotti, which is used by the author in his investigations. Salotti by comparing the heart to an ellipsoid divided it into four segments (the dividing lines being the diameters of the heart) and obtained the following formula:

$$V = \frac{a+b}{2} \cdot \frac{\pi}{3} (bc+ca+ad+db).$$

He calculated the volume as follows: Inasmuch as $\pi/3 = 1.0472$, which may be taken roughly as 1, the formula may be changed to

$$V = \frac{a+b}{2} (bc+ca+ad+db)$$

and again to

$$V = \frac{a+b}{2} c(a+b)d(a+b)$$

and finally to

$$V = \frac{a+b}{2} (a+b) \cdot (c+d)$$

in which a and b represent the two halves of the transverse diameter as measured from the usual right inferior and left superior points of the border of the heart to the longitudinal diameter and c and d represent the two parts of the longitudinal diameter of the heart from point D' and apex respectively to an intermediary point which lies in the middle between the two points of intersection of the halves of the transverse diameter. Thus the procedure is very simple and a single orthodiagram or a teleroentgenogram suffices. After defining the usual landmarks of the border of the heart, the diameters are drawn in the usual way and thus the definition into the four segments forming the basis of the above formula is made.

The author, by making use of the teleroentgenogram, and in a few instances also of the orthodiagram, extended his investigations to 300 children between six to twelve years of age, and arrived at the following conclusions: (1) the infant heart between six and twelve years is considerably larger in comparison to the body than that of the adult; (2) in girls the average dimensions of the heart are both in a relative and absolute sense smaller than in boys of the same age; (3) the volume of the heart and the individual cardiac index appeared larger in the group of children which were younger but normally developed than in the group of older children with signs of relative over-development; (4) the decrease in girls as compared to boys reached its maximum between the ages of nine and twelve. This most probably is due to the earlier development of puberty; (5) with advanced age the difference in the increase of the right ventricle above the left becomes less evident.—*T. Leucutia.*

DELHERM, THOYER-ROZAT, CODET, P.-H., and FISCHGOLD. Notes sur quelques acquisitions nouvelles de la kymographie cardio-vasculaire. (Notes on some new findings in cardiovascular kymography.) *Bull. et mém. Soc. de radiol. méd. de France*, May, 1932, 20, 263-270.

Continuing their work on kymography, the authors found that the method permits a pre-

cise study of the silhouette and especially of the left border of the heart. A differentiation between the great vessels, the left auricle and ventricle is easily made. Likewise, point G which lies between the auricle and ventricle and the median arc are determined with nearly mathematical precision. The method is further of value in the oblique and the transverse examination of the heart, inasmuch as it permits the dissociation of the shadows of the great vessels in the oblique and the study of the pulsations transmitted to the barium-filled esophagus in the transverse position.—*T. Leucutia.*

ABDOMEN.

COLIEZ, ROBERT. Dynamique biliaire. (Biliary dynamics.) *Cahiers de radiol.*, Jan. 15, No. 4, 1931.

The author describes in detail 6 cases, using numerous roentgenograms and sketches for illustration, to prove that a serial roentgen examination has great value in the study of mobile calculi of the gallbladder, and especially in the estimation of the mobility of the gallbladder in various positions.

Briefly, one may say that the organs of the right upper quadrant are subjected to the law of gravity, the liver, gallbladder and the biliary calculi, if such are present, assuming various positions according to the position of the patient. On recumbent position the inferior extremity of the gallbladder appears generally at the level of the second and third lumbar vertebrae; by changing from the ventral into dorsal decubitus the inferior border of the liver as well as the gallbladder rises slightly. In the erect position both the lower lobe of the liver and the inferior border of the gallbladder descend considerably, even reaching the level of the iliac crest.

If the gallbladder incloses free calculi, the density of which is higher than that of the bile, the calculi follow the law of gravity, that is, they descend toward the fundus in the erect position and mount toward the cystic duct in the recumbent or Trendelenburg position, the opposite being true of the calculi which are lighter than the bile. If in the lateral view the shadows are close to the abdominal wall, one may assume the presence of biliary calculi, although occasionally the presence of renal calculi in an anteriorly displaced kidney cannot be excluded. Intravenous pyelography in such instances will, as a rule, elucidate the question.

If the gallbladder appears fixed to the anterior abdominal wall (as demonstrated either by pneumoperitoneum or by the gallbladder dye method), one may assume the presence of extensive perivisceritis with adhesions of the anterior parietal peritoneum.—*T. Leucutia.*

HELD and MEESE. Die Leberzirrhose im Röntgenbild nach Thorotrastinjektion. (The roentgen appearance of liver cirrhosis following thorotrast injection.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1932, 45, 451-456.

Thorotrast was injected in 7 cases, 2 of which died from bronchopneumonia and pyelocystitis respectively. The 7 cases are briefly described and discussed. The conclusion is reached that the roentgen diagnosis of cirrhosis of the liver by means of thorotrast injection represents the surest method. The danger is relatively small, except in cases of infection. The thorotrast storage was determined by the bilirubin test and by the Congo-red storage. A differentiation of stasis from hyperplasia of the spleen was obtained with the aid of adrenalin injection. It is the authors' contention that the method may be used for the study of the various stages of cirrhosis of the liver.—*T. Leucutia.*

FETZER, H. Die Hepato-Lienographie in Verbindung mit der Cholezystographie und Pyelographie. (Hepato-lienography in connection with cholecystography and pyelography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1932, 45, 328-330.

The observations refer to patients who received 60 c.c. of thorotrast, and later intravenous uroselectan and iodotetragnost. It was found that the storage of the thorotrast in the liver and reticulo-endothelial system did not influence the elimination of the iodotetragnost from the biliary system or the excretion of the uroselectan from the renal system. Three roentgenograms showing simultaneous visualization of the liver, gallbladder and kidney are reproduced.—*T. Leucutia.*

CAMPLANI, MARIO. Contributo alla conoscenza della rare immagini colecistografiche. (Some rare cholecystographic pictures.) *Radiol. med.*, Jan., 1932, 19, 38-45.

The author briefly reviews the congenital or acquired anomalies that may be seen in cholecystography and describes a case in a woman of thirty-eight who was sent to him for chole-

cystography on account of vague symptoms in the liver region. The picture showed a pear-shaped bladder almost normal in size but divided into two parts, an upper and a lower. He concluded that this was due to a constricting band brought about by pericholecystitis. He thought there were probably adhesions between the duodenum and gallbladder and that laparotomy was required. Operation showed a gallbladder somewhat smaller than normal with evident signs of cholecystitis. It contained only a little bile, normal in appearance, and no calculi. There was a band of fibrous tissue stretched from one wall to the other dividing it into a lower and an upper part. He does not know whether this was a congenital anomaly or whether the band was a result of inflammation from a stone that had been passed.—*Audrey G. Morgan.*

VITA, GIULIO. Contributo allo studio della linitis plastica. (Study of linitis plastica) *Radiol. med.*, Jan., 1932, 19, 63-74.

The author describes a case of plastic linitis that he studied clinically and roentgenologically in which the diagnosis was confirmed by autopsy and histological examination. This is a benign condition first described by Brinton. He then discusses the differential roentgen diagnosis between linitis, scirrhus carcinoma, syphilis and tuberculosis of the stomach, cicatricial contractions and intoxications. The diagnosis of linitis is made chiefly from the internal relief of the gastric mucosa, the motility of the stomach and the disproportion between the infiltration of the stomach wall and the general health which is good. He concludes that with very careful roentgen examination the disease can be diagnosed during life.—*Audrey G. Morgan.*

McCLURE, C. C. Diseases of the large intestine *Arch. Surg.*, March, 1932, 24, 411-425.

This is a general discussion of the more common conditions encountered in the routine examination of the gastrointestinal tract. Among the introductory remarks the fact is brought out that a transverse colon that crosses the upper part of the abdomen is more or less rare. In the majority of cases, one finds that the colon falls well below the umbilicus.

Spastic Colitis. The etiology has not been ascertained. Many competent clinicians ignore its existence. The author believes it to be a real entity and one that can be definitely demon-

strated. Spastic colitis is a functional condition that may give rise to numerous symptoms, the most common of which is constipation. In the presence of the constipation, it is surprising to learn that often there is marked colonic hypermotility. According to Gauss, several theories have been advanced to explain hypertonicity. "The direct etiologic factor is an open problem today. Nevertheless, it has been observed that usually the patient with a spastic colon is a neurotic individual given to introspection, and that the hypertonicity of the colon is a local manifestation of a general spasmophilic tendency."

Ulcerative Colitis. It is probable that ulcerative colitis is caused by an infection that has been superimposed on tissues the resistance of which has been lowered as the result of a predisposing condition, such as long-standing catarrhal inflammation of the bowel or severe spasticity of the colon. The disease is apt to be sudden in its onset, with lancinating pains over the course of the colon, accompanied by griping and frequent bowel movements, and severe constitutional symptoms. The attacks occur in cycles and after a while, mucus, pus, and blood are passed. This condition may be confused with dysentery, typhoid fever or a malignant process. Cancer develops much more slowly than ulcerative colitis, and pain and griping are rarely seen early in malignant disease. In a case of carcinoma the patient is comfortable after the bowels have moved, except in the late stages of the disease, while in colitis a bowel movement fails to give relief.

Pericolitis. The chief symptoms are constipation, alternating with occasional diarrhea, constitutional disorders resulting from absorption, localized abdominal soreness or pain on pressure, a palpable mass, which may readily be mistaken for a tumor, and mucus or blood in the stools. The condition must be differentiated from appendicitis, diverticulitis and cholecystitis. This may often be accomplished by means of a barium sulphate enema, although in diverticulitis the enema is not so important as the twenty-four hour barium examination, since barium sulphate when given by mouth is so much more certain to fill a diverticulum than when given by enema.

Appendicitis. The author does not wish to imply that all cases of appendicitis can be diagnosed by roentgenography, but many cases cannot be diagnosed preoperatively by any other method. The cases in which the roentgen

study is of value are those in which there is a history of vague abdominal uneasiness or distress, with a digestion that is not up to par. The demonstration of a retrocecal appendix with its tip high up under the hepatic flexure will serve to differentiate appendicitis from cholecystitis. The presence of stones in the appendix also can be demonstrated, as well as adhesions that prevent the free movement characteristic of the normal appendix. It is not often that the appendix is found in the classic McBurney position. Delayed emptying of the appendix (from twenty-four to seventy-two hours after the head of the colon has emptied) is thought by some authorities to be evidence of chronic appendicitis.

Foreign Bodies. The progress of opaque foreign bodies can be followed through the intestinal tract by serial roentgenograms and roentgenoscopic examinations.

Tuberculosis. This is in the majority of instances secondary to a primary focus in the lungs, larynx or pharynx. Primary lesions usually develop in the cecum or anus. The predilection of tuberculosis for the large bowel is attributed to the greater speed of the intestinal content through the small bowel, which does not permit the bacilli to find lodgment there; attenuation of the bacilli by the gastric juices, their virulence not being recovered until the cecum or colon is reached; the alkaline reaction of the feces after the ileocecal region is attained, which provides a more propitious environment for the bacilli; the formation of hardened masses of feces in the cecum, which traumatize the mucosa and produce conditions favorable to infection, and the abundant lymphatic distribution in the ileocecal region, which favors the development of tuberculosis.

Several types of tuberculosis are found in the colon, the most common of which are the hyperplastic, ulcerative and miliary. The hyperplastic type occurs most frequently in the third decade. It produces a slow-growing tumor which at times is quiescent for two or three years before it attains sufficient size to occlude the lumen of the bowel. These tumors usually feel smooth when palpated and are usually fixed. The rigidity of the terminal ileal segment is a characteristic roentgenographic observation.

In the ulcerative type, the disease may progress rapidly. The mixed infection that must follow soon causes toxemia, imperfect digestion, constitutional manifestations, persistent diar-

rhea and extensive destruction of the mucosa and deeper bowel coverings.

When miliary tuberculosis of the intestines occurs the prognosis is unfavorable because it is secondary to a well-established process elsewhere, and the patient is debilitated and unable to withstand the ravages of the fast-spreading process.

Diverticula. A diverticulum is a non-neoplastic outpouching of intestine, having a lumen that connects with the bowel or that formerly connected with it. They may be congenital (true) or acquired (false), the latter occurring between the ages of forty and sixty and about twice as frequently in men as in women. They may occur in any portion of the colon, may be large or small, single or multiple, smooth or irregular. They may be without symptoms or may simulate other intra-abdominal conditions. Diverticulitis is often mistaken for carcinoma. Proctoscopic examination may reveal a small opening from which pus is draining, and pus in the bowel is suggestive of diverticulitis. It is often impossible to make the differentiation on the basis of the roentgen examination alone, but the small cavitation that is present in carcinoma is rarely seen in diverticulitis.

Carcinoma. Unfortunately, early carcinoma of the colon is difficult to diagnose roentgenographically, as a filling defect does not develop until the late stages of the disease. Patients suffering from early carcinoma seldom present themselves for roentgen examination. Fully developed cancer of the colon usually produces fairly typical symptoms. It is often difficult to pass any of the opaque medium through the area of partial obstruction by enema, though a small amount may pass the obstruction when the barium is given by mouth. When cecal carcinoma is suspected, a delay in ileal emptying is a significant sign.—*Karl Kornblum.*

FLORIS, MICHELE. Contributo allo studio clinico e radiologico delle affezioni del colon sigmoide nella donna, con speciale riguardo alla sindrome spastica. (Clinical and roentgen study of diseases of the sigmoid colon with special reference to the spastic syndrome.) *Radiol. med.*, Jan., 1932, 19, 52-62.

On the basis of 30 cases of anatomical and functional anomalies of the sigmoid colon which he has studied clinically and roentgenologically the author discusses the frequency of such conditions and particularly spastic functional dis-

turbances. The importance of these lies in the fact that they may very readily be mistaken for lesions of the internal female genitalia. Roentgen examination is of great value in making the differentiation. The therapeutic test with belladonna, which is a valuable antispasmodic, is also of importance.—*Audrey G. Morgan.*

GENITOURINARY SYSTEM

TRUCHOT, P. L'artériographie rénale. (Renal arteriography.) *Bull. et mém. Soc. de radiol. méd. de France*, Dec., 1931, 19, 493-494.

Dos Santos, Lamas and Caldas of Lisbon in 1929 introduced renal arteriography by injecting 100 per cent sodium iodide directly into the abdominal aorta (the injection being made at the costovertebral angle underneath the 12th rib, 8 cm. lateral from the median line). The author practised the method in 20 cases with quite satisfactory results. The only accidents observed were a slight iodism in one case and a mild nephritis with temporary increase of the blood nitrogen and edema in another.

The findings were interesting. Those lesions which produced ischemia or hypervascularization usually led to characteristic images while others, which were very complicated and in which no other methods were practicable, were often considerably aided by the use of this new method. Valuable information was obtained especially in two groups: (1) in renal tuberculosis in which the site of the lesion could be localized exactly, thanks to the diminution of blood supply of the part of the kidney involved, and (2) in hematurias due to beginning neoplasm in which the area of hypervascularization permitted the detection of the neoplasm in its earliest stages.

The conclusion is drawn that the method, although still of very limited use, is of certain value in very well-selected cases.—*T. Leucutia.*

COLIEZ, ROBERT, and BERGMANN, O. Une nouvelle méthode de radiographie du système urinaire par l'uroselectan. (A new method of roentgenography of the urinary system by uroselectan.) *Cahiers de radiol.*, Oct. 1, No. 3, 1930.

After describing the technique of injection as well as the roentgenographic procedure, which is that now usually employed, the authors arrive at the following conclusions: Roentgenography of the urinary system by the intravenous injection of uroselectan is of great

value. A retarded excretion signifies renal insufficiency. If only one kidney and its ureter is visualized there is a loss of function or absence of the other kidney. The procedure gives images which are more physiologic but for the same reason less precise and informative. The localization of calculi is greatly facilitated and pathologic conditions of the bladder can be demonstrated with ease. It should not supplant but supplement the usual ascending pyelography.—*T. Leucutia.*

MANEVITCH, A. E., and FROUMKINE, A. P. L'influence de la gestation sur l'état des voies urinaires étudiée par l'uroselectan et l'abrodil. (Influence of gestation on the status of the urinary paths as studied by uroselectan and abrodil.) *Presse méd.*, March 12, 1932, 40, 396-398.

The question of pyelitis in pregnancy was studied previously by various methods. Thus the Schmidt brothers used pyelo- and ureteroscopy, Prutz, Jolly and Hirsch postmortem examinations, Beaufond, Vaudescal, and Pocher and Dozsa retrograde pyelography, etc. All investigators arrived at the conclusion that the primary cause lay in the dilatation of the ureters and kidney pelvis which is produced by the pressure of the enlarged uterus.

The authors studied the problem by direct pyelography after intravenous injection of uroselectan and abrodil. They found that in all cases of pregnancy dilatation of the kidney pelvis and ureters with adynamia of the peristaltic movements and slowing up of the evacuation follows from the fourth month on, and that the anatomico-physiologic changes are more marked on the right side than on the left. This establishes very favorable conditions for the penetration of the bacteria, resulting in all kinds of secondary infections.—*T. Leucutia.*

CHEVASSU, MAURICE, and MORET, FRANÇOIS. Le moulage radiographique des cavités du rein et de l'uretère au moyen de l'uretéro-pyélographie rétrograde, d'après 1,250 cas. (Roentgenographic molds of the cavities of the kidney and of the ureter by means of retrograde uretero-pyelography in 1,250 cases.) *Bull. et mém. Soc. de radiol. méd. de France*, Feb., 1932, 20, 57-67.

One of the authors, in 1928, described the method of retrograde uretero-pyelography applied under pressure, leading to veritable molding of the cavities examined. The method was

carried out in the usual way, except that the ureteral sounds were provided with stoppers which were tightly introduced into the ureteral orifices to prevent the backflow of the opaque substance during the injection. The material was injected very slowly until the patient complained of pain.

The method has now been used in 1,250 cases with very satisfactory results. Since the introduction of uroselectan which is considerably less painful than the previously used sodium iodide, the authors were able to even inject both kidneys simultaneously without untoward effect.

The value of the method is described for the following conditions: anomaly of the ureter and kidney, pyelonephritis, carcinoma of the kidney, polycystic kidneys, renal calculi, tuberculosis, perinephritic phlegmon, traumatism of the kidney, renal ptosis, hydronephrosis, ureteral calculi, pelvic obstruction of the ureter, etc.

The authors doubt that descending urography, which has been so actively advocated recently, will ever arrive at a stage of development where such instructive images could be obtained as with the above method.—*T. Leucutia.*

SKELETAL SYSTEM

SKOSSOGORENKO, G. F. Calcinosis interstitialis universalis. *J. Bone & Joint Surg.*, April, 1932, 14, 339-345.

Calcinosis interstitialis universalis and arthritis nodosa are terms applied to the rare and peculiar disease involving the calcium metabolism, the etiology of which is not clear. Its treatment has not yet been evolved. Clinically this disease shows multiple deposits of calcium salts in the subcutaneous, periarticular, peritendinous, perimuscular, perinervous, perivascular, adipose or interstitial tissues. These deposits vary in size from a millet seed to a pigeon egg, and usually have the appearance of platelets, clots or crumb-like masses, with smooth but mostly uneven edges. Each individual case may vary in its distribution of the calcium deposits. Occasionally the latter present a symmetrical distribution.

As to the chemical nature of the deposits, some authors have called them carbonates, others, phosphates. All ages are subject to the disease. Repeated infection often aggravates the condition. In adults the location of the disease is more apt to be limited than in

younger subjects, and its clinical course is usually benign. Some writers speak of the progressive and the regressive types.

The author reports one case in detail. No convincing information could be found in the literature regarding successful treatment. He discusses the various theories of its etiology. Since none of these hypotheses have been definitely verified, no outline of treatment can be given. The wide distribution of edema in his case seemed to have a great influence on the pathological changes of the disease. The pathological examination of the excised specimen from the edematous leg of his patient showed changes which he considered as the result of compression of the long-continued edema, which rendered the tissues unstable and passive to the deposit of calcium. Probably the disturbance in the calcium balance which was noted resulted from the atrophy of the osseous system under the influence of the compression of the edema, and the simultaneous disturbance of the function of the kidneys. His treatment consisted in introducing daily by mouth a solution of ammonium chloride combined, after an interval of one and one-half to two hours with the application to the extremity of Bier's hyperemia. This was based upon the fact that solution of ammonium chloride by mouth is apt to produce blood acidosis which in turn has its influence upon the osseous system by alkalizing the calcium salts. This treatment resulted in a decrease in the size of the calcium nodules as determined by palpation. The patient felt greater ease in the affected joints.—*R. S. Bromer.*

KAPLAN, EMANUEL B. A case of multiple spontaneous fractures of unknown origin. *J. Bone & Joint Surg.*, April, 1932, 14, 412-415.

While multiple spontaneous fractures are observed not infrequently in children, they are also seen in adults, although less often. Kaplan states that the case, he here reports, presents certain peculiarities which make the differential diagnosis difficult. The patient was a white female, about thirty-five years old, with complaints of weakness and fractures of the fingers of the hands. The fractures occurred in the usual course of her work of manicuring. A complete examination of the skeleton revealed fractures of the shafts of all the metatarsals and old fractures of the proximal phalanges of the second and fourth toes; old fractures of the right tibia and left fibula; united fractures

of the second and third metacarpals, right hand and a united fracture of the proximal phalanx, left hand with excess and irregular new bone production; old united fractures of the ulnae.

Idiopathic fragilitas ossium, osteomalacia, Schulze's marble bone disease, osteoporosis, rickets and neurotrophic, parasitic and neoplastic pathological changes could be considered in the differential diagnosis. The history of the late appearance and the peculiar localization of the fractures, he says, rules against fragilitas ossium. The normal condition of the patient's pelvis and spine, the occurrence long after pregnancy and the roentgen appearance makes osteomalacia improbable. Marble bones presents an entirely different roentgenographic appearance. Repeated laboratory and clinical examinations did not disclose the presence of any chronic or parasitic infection. No signs of multiple neoplasms nor of neurotrophic disease were found. Kaplan does not offer a diagnosis.—R. S. Bromer.

COMPÈRE, EDWARD L., *Streptococcus viridans* osteomyelitis. *J. Bone & Joint Surg.*, Apr 1, 1932, 14, 244-258.

Compère reviews and discusses the etiology of osteitis that is characterized by a fibroblast and giant-cell proliferation with bone destruction and new bone formation. He reports a case in which a strain of green-producing streptococcus grew in cultures of a lesion in the neck of the astragalus, which presented a microscopic picture similar to that of localized osteitis fibrosa without cyst formation. Clinically and bacteriologically it was a low grade pyogenic infection and he classes it as *Streptococcus viridans* osteomyelitis. He also reports a second case, which was clinically and pathologically similar to the first, except for bone proliferation, but in which cultures were negative. He suggests that trauma may be a factor in localizing the infection, but also expresses the opinion that reaction to trauma and hemorrhage could not alone account for the cortical absorption and the extensive new bone formation which was noted in his second case.

He states that it is most probable that the reason for the dearth of information concerning the incidence of *Streptococcus viridans* infections in bones is due, not so much to the rareness of the disease as to the failure of physicians to apply the technique elaborated for the investigation of streptococcus infections of the soft parts,

to infections of bone. Using the technique which he employed in the two cases here reported (first employed by Rosenow for the isolation of such organisms), Phemister, Brunschwig and Day succeeded in culturing *Streptococcus viridans* in two cases of Kienböck's malacia and one each of Köhler's disease, Legg-Perthes-Calvé's disease, and osteitis deformans. He suggests that the culture of these organisms in his first case, combined with the fact that Phemister and his coworkers have isolated *Streptococcus viridans* in culture from the lining wall of 4 cases of solitary bone cyst, adds an etiological link to the evidence that the two pathological conditions, namely, the so-called brown tumors of bone or giant cell tumors and bone cysts, may perhaps be different stages of the same process. While the lesion in neither of his two cases is typically that of the true benign giant cell tumor, the microscopic picture is similar to that seen in lesions classified in the osteitis fibrosa group.—R. S. Bromer.

CAPENER, NORMAN, and PIERCE, KENNETH C. Pathological fractures in osteomyelitis. *J. Bone & Joint Surg.*, July, 1932, 14, 501-510.

This paper is based upon a study of 1,066 cases of osteomyelitis. The authors were stimulated to make this study as they had found an extreme paucity of references to fractures in osteomyelitis in the literature. They desire especially to investigate the necessary precautions for prevention of these fractures. Delayed recognition of the disease and inadequate treatment in the early, acute stage are important factors in their occurrence. These both may be responsible for massive diaphyseal sequestration. They state that where there is sequestration involving the whole circumference of a long bone, the condition is essentially one of fracture, although none of the classical signs of fracture may be present because of the development of a supporting involucrum. Thus pathological fracture is a complication of the chronic stage of osteomyelitis, except in certain cases of epiphyseal separation due to an extensive acute metaphysitis.

Secondary factors are: (a) excessively large diaphyseal separation and (b) the formation of an involucrum that is inadequate to stand the normal stress brought to bear upon the limb. In addition, fracture is facilitated by imperfect immobilization and support of the diseased bone, and is therefore more commonly found in the single bones, the humerus and the femur.

than in those that have a companion bone for support.

This study revealed that pathological fractures in cases of osteomyelitis of the shafts of the long bones occurred in 1.66 per cent of a total of 1,068 cases. Osteomyelitis was responsible for 33 per cent of all pathological fractures in the long bones. They recommend that every case with massive sequestration should be regarded as a fracture before abnormal mobility or deformity is evident. A deep gutter rather than a shallow saucer is a safer mechanical means of dealing with central bone abscesses. In the removal of sequestra the involucrum should be conserved. Careful attention should be paid to the proper provision of splints or other support during convalescence.—R. S. Bromer.

KING, DON. Osteochondritis dissecans; a clinical study of twenty-four cases. *J. Bone & Joint Surg.*, July, 1932, 14, 535-544.

King's study is based upon 24 cases of osteochondritis dissecans which from the standpoint of clinical history fell into three fairly well-defined groups. In one group were the very painful, swollen, tender joints, locked in 15 to 45 degrees of flexion. The appearance suggested traumatic injury. The trouble began very suddenly a few days previous, subsequent to a twist or other minor injury. There was usually no history of previous disability. Roentgen examination revealed an osteochondritic focus of the medial femoral condyle, with two or three loose bodies in the joint.

The second group included cases which were asymptomatic. It occasionally happened that a roentgenogram of the supposedly normal knee, taken for comparison, revealed a definite osteochondritic focus, without free bodies in the joints. The body or "mouse" was lying quietly in its bed on the medial femoral condyle. These patients had "slumbering osteochondritis dissecans."

The largest number of cases was in the third group. In this group there was a definite history of trauma in a few cases. The story was that of a troublesome knee joint during two or three years. The complaint was a feeling of soreness, or definite pain on weight-bearing, associated with swelling. "Giving way" and stiffness were also common. These symptoms were sometimes continuous but more often intermittent, and were often associated with recurrent sudden "locking" of the joint on arising from a sitting

or squatting position. Five of this last group felt a loose body in the joint.

In only one case did history and clinical examination lead to a suspicion of osteochondritis dissecans, all of the rest being diagnosed by roentgen examination. The three most usual clinical diagnoses were torn cartilage, tuberculosis, and loose body.

In the roentgenogram of the knee joint the process was almost always found on the postero-internal aspect of the medial femoral condyle on the articular surface. The entire focus appeared as a well-localized, almond-shaped area of lessened density, within which was a small sclerotic mass. Occasionally in the condyle at the edge of the focus there was a cystic area resembling a series of signet rings of different sizes, opening into the focus bed. The articular cartilage over the focus had a shredded appearance. Small portions, or rarely the entire sclerotic mass, appeared free in the joint. Old cases coming under observation for the first time usually had several loose bodies in the joint associated with arthritis. Occasionally in all these cases the original osteochondritic process was healed to such an extent that it could easily have been missed, all attention being concentrated on the arthritic process and the loose bodies. In the 4 elbow cases, the osteochondritic focus was found in the capitulum, with an irregularity and broadening of the radial head and in old cases with an increased length of the coronoid process and a thickening of the superior olecranon surface. Radical operation gave a good result in 88 per cent of cases. Slumbering osteochondritis dissecans should be treated conservatively without operation, as spontaneous healing has been demonstrated in these cases. Long-standing cases with many free bodies and severe arthritis may not be cured by operation, because many of the subjective symptoms are due to the accompanying arthritis.—R. S. Bromer.

JAFFE, HENRY L., and MAYER, LEO. An osteoblastic osteoid tissue-forming tumor of a metacarpal bone. *Arch. Surg.*, April, 1932, 24, 550-564.

Benign tumors of the short tubular bones of the hands and feet are relatively frequent; malignant tumors occur rarely. The authors describe a tumor of a metacarpal bone that began in a girl twelve years of age. The tumor was of slow growth. A biopsy showed osteoid tissue and numerous osteoblasts. Two years

later the tumor began to grow rapidly. After growing rapidly for about six months, an encapsulated mass measuring 10 by 6.5 by 6 cm. was removed. There was almost complete destruction of the metacarpal bone. The peculiar feature of this osteoblastic tumor was its capacity to produce large amounts of osteoid tissue, much of which was free from calcium. The tumor had some features common to cartilaginous elements in numerous sections. It was especially characterized by homogeneity of the histologic picture, a lack of polymorphism of the cells and an absence of tumor giant cells.

There has been no recurrence one and a half years after operation and the patient has remained free of metastases for over four years after the original biopsy. The authors believe that the case is an example of the so-called "osteoid chondroma" of Virchow, which is an osteoid tissue-producing tumor, the prognosis of which is better than that of osteogenic sarcoma. It was thought that had extirpation of the metacarpal bone been delayed much longer, the tumor probably would have undergone biologic transformation and developed the malignant capacities of true osteogenic sarcoma.

The case is reported in considerable detail with numerous illustrations showing the hand before and after operation, roentgenograms of the tumor at various stages in its growth, and many photomicrographs showing the histologic nature of the lesion.—*Karl Kornblum*.

COHN, BERNARD N. E. Congenital bilateral radio-ulnar synostosis. *J. Bone & Joint Surg.*, April, 1932, 14, 404-405.

Radio-ulnar synostosis, or "congenital pronation" is a rare developmental anomaly involving the bones of the forearm. It consists of bony fusion of the proximal ends of the radius and ulna which are otherwise normal. This abnormality prevents normal rotation of the forearm, and occurs more frequently in males and is bilateral in about 50 per cent of cases. There is some evidence of a hereditary tendency. Other bony defects may or may not be present. Cohn's case is bilateral, occurring in a male, with no history of the same abnormality in other members of his family.

Roentgenographic examination of both elbows revealed a solid bony union between the proximal ends of the radius and ulna for a distance of 5.5 cm. The heads of the radii were present but were displaced somewhat ante-

riorly, thus accounting for the limitation of flexion on clinical examination. The humeri were normal.

The case history contains no mention of treatment, but is illustrated by roentgenograms.—*R. S. Bromer*.

FAHLSTROM, STANLEY. Radio-ulnar synostosis; historical review and case report. *J. Bone & Joint Surg.*, April, 1932, 14, 395-403.

In radio-ulnar synostosis, generally thought to be congenital in origin, the upper ends of the radius and ulna are always involved and the lower ends are free. Supination is greatly impaired and the hand is held in a position of constant pronation. The condition is painless, is compatible with normal existence and offers poor promise from surgical intervention. A strong familial tendency has been noted and it occurs bilaterally in half the cases.

Two types are known to occur. In the first—true radio-ulnar synostosis—the radius and ulna are smoothly fused at their proximal borders for a variable distance, usually 2 cm. In the second form there is a radio-ulnar synostosis with congenital dislocation of the head of the radius. There is also an acquired form which results from trauma such as fracture or gunshot wound.

Kaplan gives a long and complete historical review with an extensive bibliography, containing 134 references. His case is illustrated by roentgenograms, showing the fusion of the radius and ulna.—*R. S. Bromer*.

WATSON, WILLIAM L. Fractures of the lower radial epiphysis. *Arch. Surg.*, March, 1932, 24, 492-504.

The lesion dealt with in this article is one in which there is a solution of continuity in the radius at its lower extremity, and all, or at least part, of the line of separation passes through the cartilaginous plate of the epiphysis. This should be called a fracture instead of a separation or dislocation.

The anatomy of the part is discussed. Attention is called to the fact that nearly the entire blood supply of the epiphysis comes from the overlying periosteal network of arteries. The blood supply of the epiphysis is therefore independent of the diaphysis which accounts for the comparatively infrequent occurrence of necrosis in traumatic separation of the epiphysis. The epiphysis toward which the nutrient artery points usually unites to the shaft first, and con-

sequently the greater longitudinal growth is produced by the opposite epiphysis. The lower radial and ulnar epiphyses unite later than the upper ones do, and so produce the greater longitudinal growth. The age at which epiphyseal ossification takes place in the radius and ulna has been variously reported. The average is eighteen years for the head of the radius, from sixteen to seventeen years for the head of the ulna, and nineteen years for both distal epiphyses.

Regarding incidence, fracture of the lower radial epiphysis is the most common of all the epiphyseal fractures. The majority of cases are seen in the second decade of life. The injury is relatively uncommon after eighteen years of age. Most of the patients are of the male sex. The epiphysis is relatively more resistant to trauma than the lower end of the radius in adult life.

These fractures are nearly always due to indirect violence. A back thrust from a fall on the outstretched hand or from hyperextension is the usual cause, or, as Cotton said, the causes are the same as those which produce a Colles' type of fracture in the adult. The displacement of the lower radial epiphysis is usually upward and backward. Impaction is rare. Roentgenograms of the normal as well as the injured wrist should be taken in the anteroposterior and lateral directions. It is well to note that epiphyseal fractures without displacement often cannot be picked up by roentgenography and are commonly diagnosed as "sprains." Unfortunately, these undiagnosed fractures are prone to result in arrest of growth.

Treatment consists of reduction and immobilization for from eighteen to twenty days. There is little tendency for the deformity to recur after complete reduction. The union is more rapid than in Colles' fractures in adults. In complicated cases, an open operation may be necessary. If there is subsequent cessation of growth of the radius after epiphyseal injury, it may be necessary to remove a section of the shaft of the ulna to overcome the resulting deformity of the wrist or, conjugal chondrectomy, that is, excision of the conjugal cartilage of the ulna, may be performed to produce arrest of growth of the ulna.

Various complications may occur. The most important is a disturbance in growth activity. The severity of the resulting deformity is dependent on the degree of injury to the epiphyseal cartilage and its blood supply. Minor in-

juries to these structures cause retardation of longitudinal growth and more severe injuries produce a premature ossification of the epiphysis to the diaphysis, the resulting degree of wrist deformity being greater the younger the patient is at the time of the accident.

Regarding prognosis, no cases of non-union have been reported, and, in the uncomplicated cases, union takes place in the second or third week. The resulting wrist function is good.

The literature contains very few references to the treatment for premature ossification of the lower radial epiphysis. The author reports two cases of this kind, in one of which an operation was performed and in the other no operation was done.

Conjugal chondrectomy is the operation recommended by the author.—*Karl Kornblum*

LANG, F. J. Osteo-arthritis deformans contrasted with osteo-arthritis deformans juvenilis. *J. Bone & Joint Surg.*, July, 1932, 14, 563-573.

Lang bases his study of the adult and juvenile types of osteoarthritis deformans upon the anatomical and histological changes present in the two types of the disease. Osteoarthritis deformans is a chronic non-infectious and proliferative inflammation that leads to a deformity of the joint structure. Marginal exostoses are characteristic and constitute the decisive feature for the diagnosis of the condition. These marginal exostoses are not ossified excrescences, or periosteal or perichondral proliferations, or osteophytes, or periosteal lippings; they are bone formations, which arising from the subchondral marrow tissue grow out into the joint cartilage. They possess a laminated structure, are united to the spongiosa and are usually covered with cartilage. The joint cartilage shows alterations in consistency associated with a splitting of the ground substance which disturbs and damages the elasticity of the cartilage. As a sequel of vascularization and ossification of the cartilage its deeper portions are undermined. The portions thus separated by undermining are often found to lie deep within the spongiosa and, in this position, they mark the site of the original boundary between bone and cartilage. Despite the changes in the surface of the cartilage, vascularization and ossification of the basal layer cartilage rarely take place. The cause for this is either that the calcification zone of the joint cartilage is very broad, or the subchondral bone is very compact. The

subchondral bone is thus protected against functional and mechanical damage in spite of the loss of elasticity in the overlying cartilage. So it is obvious that arthritis deformans is dependent for its development on a combination of functional and anatomical circumstances.

Lang describes the histological changes in great detail and, after due consideration of his findings, concludes that the distinction between the atrophic and the hypertrophic or between the degenerative and the hyperplastic types of arthritis deformans is not necessary. The varieties are but gradations of a process that is uniform as regards its origin.

A distinction between the chondral and the osseous forms of arthritis deformans is also unnecessary. In the final analysis, it is the damage to the cartilage with its resultant loss of elasticity that is responsible for the origin of the disease. Under all conditions the character of arthritis deformans is a chronic, proliferative, non-infectious inflammation of the joint and therefore the only justifiable designation of this process is "arthritis." "Arthrosis" is a term which should not be used as it implies a degenerative process.

Regarding the causes of the condition, Lang admits that a direct relationship exists between arthritic change and certain systemic diseases. The functional theory of Pommer offers a satisfactory explanation in that it presupposes that the joint cartilage, through its elasticity, protects the subchondral bone and its marrow from the irregular, localized effects of impacts, jarrings, and pressures arising from normal function. Following damage to the joint cartilage, with subsequent loss of its elasticity, the mechanical effects of normal joint function become more or less localized and are transmitted unmodified to the joint structure resulting in

a reactive vascularization and ossification of the cartilage. The recognition of the functional and mechanical importance of joint cartilage as the protective covering of the subchondral bone demands that the mechanical and functional damage to the joint cartilage be adjudged the most important factor, not only in the pathogenesis, but also as the etiological factor of arthritis deformans. In Lang's study of juvenile joints he was able to substantiate the theory that arthritis deformans is already initiated in the early years of life and, therefore, the disease has to be considered as a consequence of trauma carried over from childhood and adolescence. In his investigation of the juvenile form of arthritis deformans in cases of Legg-Perthes-Calvé's disease of the hip joint and Köhler's disease of the first and second metatarsal bones and other so-called aseptic necroses, he found the characteristic diagnostic features of arthritis deformans, namely, changes in the joint cartilage, vascularization and ossification of the cartilage, and marginal exostoses. He found it evident that functional traumata are the determining factors for the origin of juvenile arthritis deformans.

He concludes that there are no fundamental differences between arthritis deformans of the adult and juvenile arthritis deformans. Both types originate after damage to the articular and joint cartilage with subsequent loss of its elasticity. This loss of elasticity removes the protection that the normal cartilage affords to the subchondral bone against functional and mechanical influences. The decisive factor for the progressive course of both types is the action of the functional requirements which, acting as a source of constant irritation, form the basis for the progressive character of the disease.—*R. S. Bromer.*



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THE INTERPRETATION OF THE TRIANGULAR BASAL SHADOWS IN ROENTGENOGRAMS OF THE CHEST*

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TO SAY that the use of lipiodol as an aid in the study of pulmonary disease has been a tremendous boon to both roentgenologist and internist and has greatly increased the accuracy of roentgen interpretation is an obvious platitude—but an excusable one. Especially has the use of this opaque oil been of service in connection with the study of bronchiectasis which is now revealed in a variety of forms previously unsuspected.

One of the problems upon which light has been thrown by this method of investigation has to do with the interpretation of the so-called triangular basal shadows occasionally seen in roentgen studies of the chest, a subject which upon first contact seems one of minor importance but which has been the means of bringing to our attention several facts of extreme interest not hitherto given much prominence in the study of chest pathology.

Most roentgenologists have been perplexed at one time or another by the presence of these shadows and, judging by the lack of satisfactory explanation in the literature, have failed to arrive at any entirely conclusive answer.

Singer and Graham,¹² in 1926, called at-

tention to the condition and identified it as an atelectatic lower lobe, a phase of bronchiectasis. Their observations were verified during the surgical treatment of their cases but were not studied by means of opaque substances prior to operation to any extent.

Nitsch, in an interesting paper in 1901, makes reference to paravertebral triangular densities which were almost certainly these same triangular areas, though this work was not based upon roentgen investigations during life.

Sante⁹ refers to the presence of bronchiectatic areas in the lower lobe hidden by the heart shadow and gives an illustration which is a typical example of the lesion to which the present paper refers.

But with these exceptions, English literature has been peculiarly silent regarding the condition until very recently, and it is probable that the finding was usually missed or at least misinterpreted by most observers.

Since our attention was first drawn to the finding it has been encountered 10 times in 2,000 consecutive routine chest examinations and would thus seem to be of sufficient importance to the clinical roent-

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

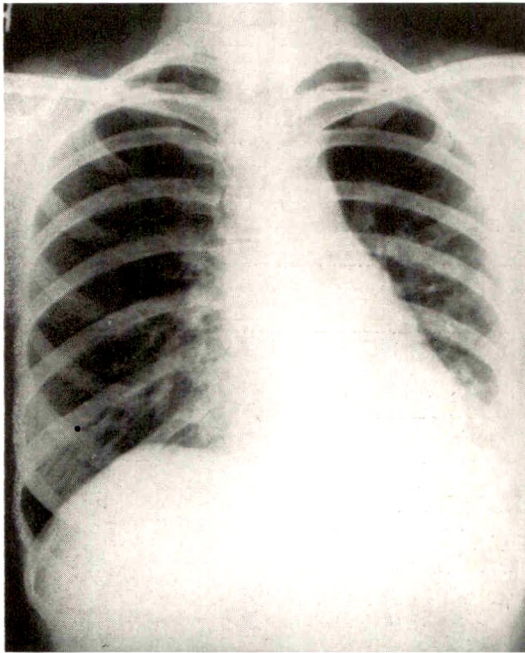


FIG. 1. Case 229,730. Typical unilateral lesion left side; triangular shadow hidden behind the heart.

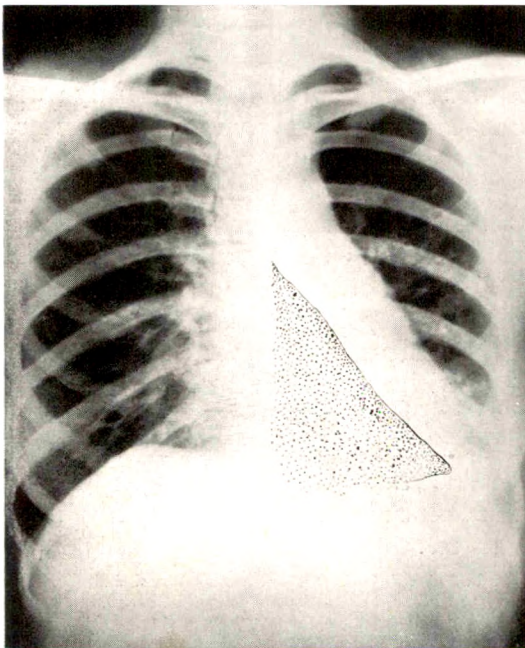


FIG. 2. Case 229,730. Same case retouched to indicate more clearly the outline of the shadow described.

genologist to justify again directing attention to it in view of our present methods of investigation.

The term "triangular basal shadow" is a fairly accurate descriptive term as the areas of increased density are usually more or less triangular in outline occupying the angle formed by the heart and diaphragm on either side of the vertebral shadow. The outer border of the areas is a straight or slightly curved line extending from above



FIG. 3. Case 229,730. Following introduction of lipiodol, showing extensive cylindrical bronchiectasis.

downward and outward to the diaphragm, thus completing the triangle. Many slight modifications of this general form are obviously quite possible and several are presented herewith.

1. *Typical Unilateral Shadow* (Figs. 1, 2, 3 and 4). This case shows a very characteristic shadow though somewhat difficult of demonstration because it is situated behind the heart shadow. In the original films there is to be seen a very definite area of increased density behind the heart, the outer border of which forms a sharp, well-de-

lined line of demarcation enclosing the whole cardiophrenic angle.

Following the injection of lipiodol it is at once seen that this entire area is composed of atelectatic lung containing numerous bronchiectatic cavities. Further, it is apparent that the area of lung involved represents the whole of the lower lobe of the involved side as may be seen by careful study of the distribution of the bronchial trunks.

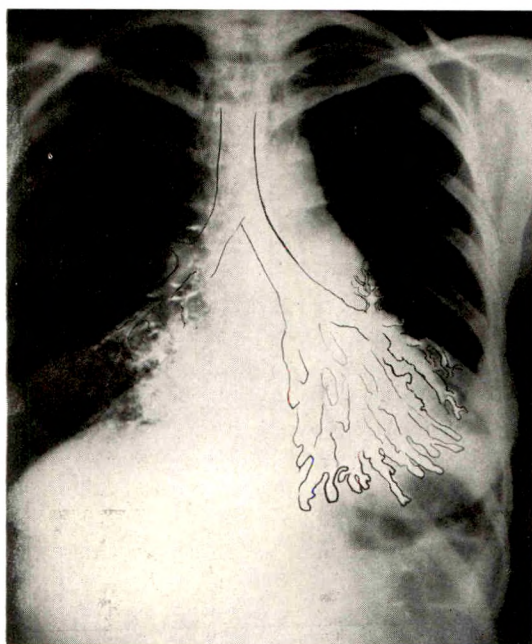


FIG. 4. Case 229,730. Same film retouched to bring out: distribution of entire left lower bronchus to involved area; rotation of bronchus downward, and expansion of remaining lobe.

2. *Typical Bilateral Shadow* (Figs. 5, 6, 7 and 8). In this case the shadow on the right side is sufficiently typical to be described as triangular, while on the left it is more irregular in outline, yet conforming on the whole to such a description.

Following the injection of lipiodol it is again evident that the entire distribution of the right lower main bronchial trunk is within the involved area on the right side and the left lower main bronchus within a similar area on the left.

The conclusion reached by Singer and

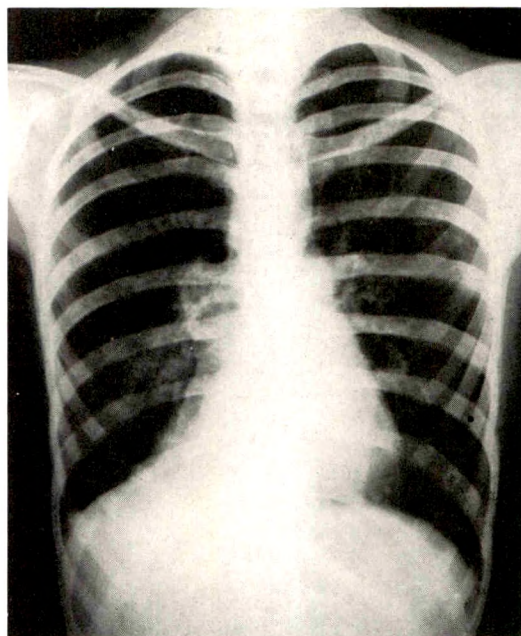


FIG. 5. Case 253,968. Typical bilateral shadows.

Graham, therefore, is confirmed that these are areas of atelectatic lung in which bronchiectasis is present. Two features of unusual interest are to be seen in these cases. The first is the small space which may

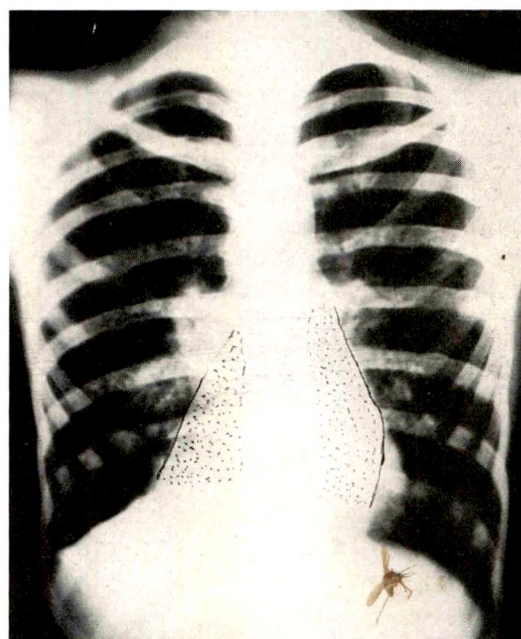


FIG. 6. Case 253,968. Areas retouched.

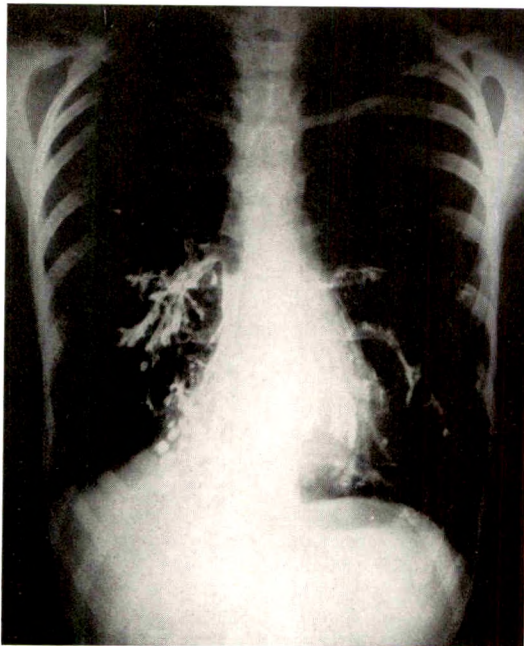


FIG. 7. Case 253,968. Following introduction of lipiodol.

be occupied by an entire lobe of lung when collapsed in this manner; the second the degree of rotation which the bronchi undergo.

In each case which has been observed on the left side the entire area of pathological density has been covered by the heart shadow. In one of these (Figs. 9 and 10), the shadow is a very small ovoid area lying along the side of the spine and is almost a perfect roentgen picture of tuberculous abscess complicating Potts's disease of the thoracic vertebrae. The diagnosis is immediately clarified by the use of lipiodol but would scarcely be possible by any other means.

On the right side the small space into which the lung may collapse is less striking but even here the entire lower lobe may be contained within the cardiohepatic angle.

Kerley⁴ in a very interesting paper states that these areas are all collapsed accessory lobes, the lesion being originally a congenital anomaly.

"Schaffner found a well-developed fourth lobe in the right lung in fifteen per cent of normal individuals, and a third lobe in the left

lung in a slightly smaller percentage. In no less than forty per cent of normal people evidence of accessory lobes can be found in a furrow running across the lower part of the lower lobes. These figures have since been verified by Müller and Gräberger . . . Without any shadow of doubt, we are in a stage of human evolution when we are discarding a fourth lobe in the right lung and a third lobe in the left lung. The remnants of these lobes are a potent factor in the development of bronchiectasis."

Kerley's conclusion is that this lesion is always associated with such an accessory lobe. Whether this conclusion ultimately proves to be correct there seems no doubt that such lobes are much more common than has hitherto been known.

Rigler and Ericksen⁷ in a paper now in process of publication has reviewed the literature and kindly allowed me to quote from their manuscript.

"Gräberger has recently called attention to the roentgenological manifestations of the basal median lobe of the lung, an accessory lobe occurring on either side, but it was first described by Rektorzik in 1861. It is therefore sometimes called the inferior accessory lobe of

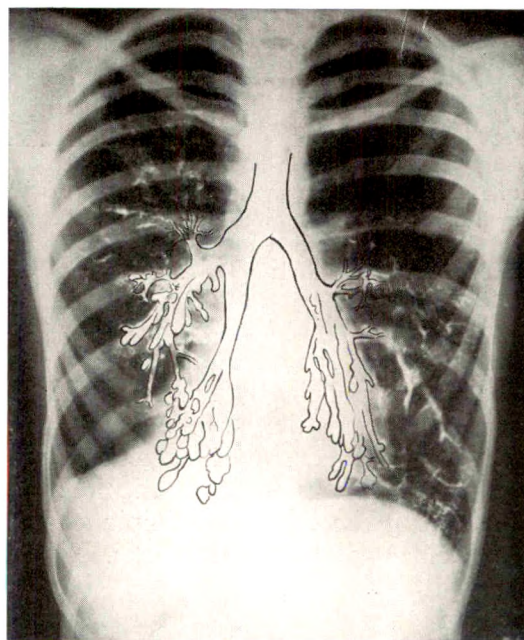


FIG. 8. Case 253,968. Tracing from Figure 7 to illustrate distribution of bronchus rotation, etc.

Rektorzik. It is well known to comparative anatomists that, almost without exception, a basal lung division, often called the cardiac or retrocardiac lobe, occurs on the right side in quadrupeds. The human inferior accessory lobe appears to develop from this heart lobe of animals and is supplied by the heart bronchus. When present on the left side it is supplied by the medial branch of the second anterior bronchus.

"Schaffner, in 1898, examined 210 human lungs post-mortem, and found this lobe to be present, partially or entirely formed, on either the right or left sides, in 45.7 per cent of the lungs.

"The incidence in the 210 lungs was as follows:

Completely formed, right side,	15 times
Completely formed, left side,	13 times
Completely formed, bilateral,	3 times
Partially formed, right side,	31 times
Partially formed, left side,	37 times
Partially formed, bilateral,	15 times."

Rotation. The second point of special interest in these cases is a natural result of the first, viz., the amount of downward

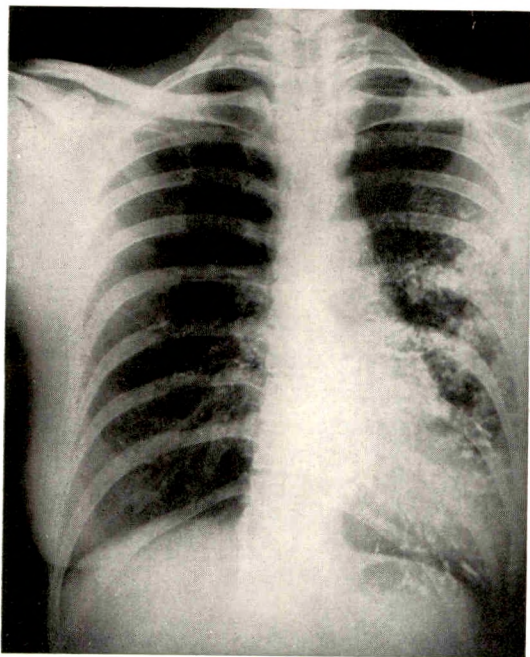


FIG. 9. Case 259,304. Small ovoid shadows lying close to spine simulating in original films tuberculous abscess or aneurysm. This is an example of accessory lobe.

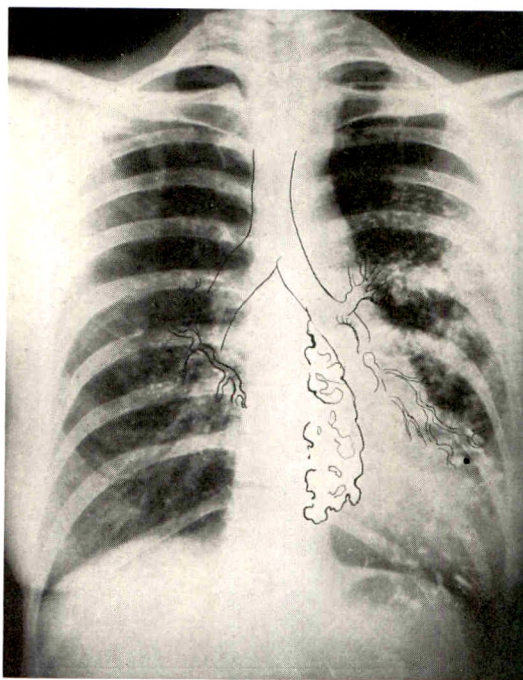


FIG. 10. Case 259,304. Tracing of Figure 9. Bronchus comes off low down posteriorly, probably accessory lobe. Unverified.

rotation which the bronchi must undergo to permit the collapse of one lobe into so small a space and the corresponding expansion which must take place in the remaining lung in order to permit it to occupy the remaining thoracic space.

The degree of rotation which takes place is very clearly seen by comparing Figure 11, which is a normal right bronchial tree, with Figure 8, one of the cases presented. In this particular instance the bronchi have rotated downward through 27° and 18° respectively. This is no doubt an extreme example and would seem to be almost the limit of possible rotation, but in all of the cases studied this feature has been quite striking.

Equally interesting is the expansion of the remaining lung which in each case is seen to expand sufficiently to fill the entire remaining thoracic space.

Differential Diagnosis. When one comes to carefully analyze the cases in which the diagnosis has been established, it would seem that a correct diagnosis, even from

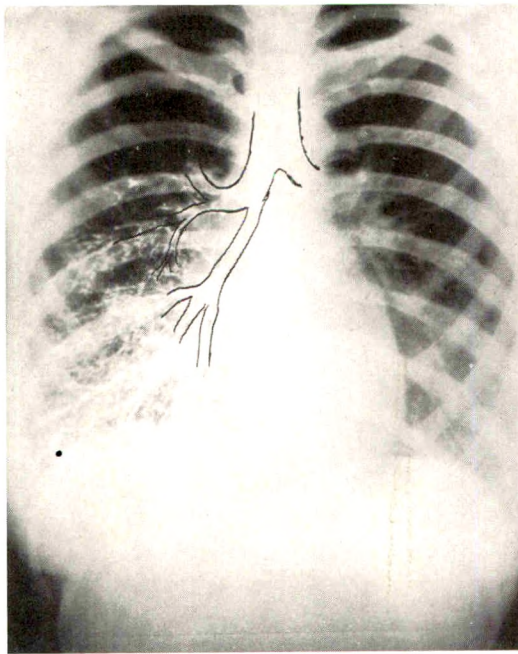


FIG. 11. Case 241,922. Tracing from normal bronchial tree for comparison with Figure 8 to illustrate downward rotation which bronchi undergo.

plain films without the opaque oil, should not present great difficulties, although it is obvious that lipiodol places within our hands the means of final demonstration.

Undoubtedly, the most common error in the past has been to consider these areas as due to pleural thickening and as they are observed rather infrequently this is perhaps a natural error. As soon, however, as a group of films showing the shadow are studied together this would be immediately apparent as an error and in the future will seldom be made. Equally apparent is the fact that the shadow is not adequately explained as an empyema or an area of pneumonic consolidation, though Rigler quotes a case of pneumonia occurring in one of the accessory lobes in this region. In one of our cases here presented (Fig. 9 prior to lipiodol), there might be justification for a diagnosis of either Pott's disease with abscess formation or aneurysm of the descending aorta, and in the absence of lipiodol it would be difficult, if not impossible, to reach a conclusive decision.

Kerley describes a case of tuberculosis occurring in a right lower accessory lobe, and several cases of primary carcinoma in such lobes have also been described. Thus the differential diagnosis renders the use of some opaque medium almost essential.

Finally, it will be noted that this form of atelectasis does not at all resemble in its roentgen appearances the massive atelectasis with which we are more familiar. At least in the cases we have had the opportunity to study there has been no elevation of the diaphragm, no shifting of the mediastinum and the shadow has always been comparatively small and confined to the paravertebral angle. In this group Figure 9 is considered to be an accessory lobe (though this is unverified) while in the others the main lower bronchus may be traced in its entirety into the involved lobe and we have felt convinced that an entire lobe, not merely an accessory or partial or accessory lobe, was involved in the collapse. This has been verified in those cases thus far operated upon.

The pathological physiology underlying the condition has been studied by Prof. Duncan Graham and Dr. W. P. Warner and reported by them in a separate communication. They have succeeded in producing the condition experimentally by obstructing the main bronchus, such obstruction, as might have been expected, being immediately followed by the development of a typical bronchiectasis.

The conclusion which one feels justified in reaching is that the finding of such shadows in roentgenograms of the chest is pathognomic of atelectasis with bronchiectasis. Our present opinion is that this may occur in accessory lobes as reported by Gräberger, Kerley, and others, but that it also commonly involves entire lobes of the lung and that roentgenologists should devote much more care to studies of the bases of the lung than they have done in the past. Careful reading of the articles by Kerley and Rigler and Ericksen is recommended to those interested in the subject.

REFERENCES

1. ASSMANN, H. Quoted by Rigler and Ericksen, ref. 7.
2. ETTIG, F. Quoted by Rigler and Ericksen, ref. 7.
3. GRÄBERGER, G. Quoted by Rigler and Ericksen, ref. 7.
4. KERLEY, PETER. Congenital diseases of the lungs. *Brit. J. Radiol.*, 1932, 5, 234-240.
5. LAURELL, H. Quoted by Rigler and Ericksen, ref. 7.
6. REKTORZIK, E. Quoted by Rigler and Ericksen, ref. 7.
7. RIGLER, L. G., and ERICKSEN, L. G. The inferior accessory lobe of the lung. *AM. J. ROENT-GENOL. & RAD. THERAPY*, March, 1933, 29, 384-392.
8. SAGEL, J., and RIGLER, L. G. Quoted by Rigler and Ericksen, ref. 7.
9. SANTE, L. R. The Chest Roentgenologically Considered. Paul B. Hoeber, Inc., New York, 1930, pp. 180, 181, 183.
10. SCHAFFNER, G. Quoted by Rigler and Ericksen, ref. 7.
11. SCHÖNFELD, H. Quoted by Rigler and Ericksen, ref. 7.
12. SINGER, J. J., and GRAHAM, E. A. Roentgen-ray study of bronchiectasis. *AM. J. ROENT-GENOL. & RAD. THERAPY*, 1926, 15, 54-58.



ROENTGENOLOGICAL MANIFESTATIONS OF ALLERGIC PROCESSES IN PULMONARY TUBERCULOSIS*

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THE subject of this presentation was chosen on account of the common experience that of all the various phases of pulmonary tuberculosis, the acute manifestations are most frequently misinterpreted. These acute phases are precisely the ones which, for therapeutic reasons, should be diagnosed without delay. But subjective symptoms, physical and roentgenological findings are frequently so uncharacteristic that the differential diagnosis is quite difficult. Another reason for the frequent misinterpretation of these acute phases is the customary representation of pulmonary tuberculosis as a strictly chronic disease. The exquisite chronicity of the disease as a whole is so impressive that intervening acute phases are readily overlooked or interpreted as intercurrent non-tuberculous diseases. Only since serial roentgenological studies at brief intervals have been made, during the last ten or fifteen years, has it become known how eminently important a rôle is played by acute phases.

Experimental work furnished a proper basis for the understanding of acute phenomena. The unmodified primary infection in an animal causes a characteristic slow development of specific lesions with a much delayed appearance of few clinical symptoms. When, however, the course of reinfections is studied, there appear strikingly acute phenomena, both in regard to anatomical changes and to constitutional symptoms. Allergy, the modified reactivity of the body caused by a previous infection, alters profoundly the development of infection.

Allergic reactions are well known in their morphological detail, in their causative mechanism, in their dependence on dosage

and virulence of first and second infections, on the time interval between these two events and on the locus of reinfection. In experimental work where these details can be strictly controlled, it is more or less predictable whether a given reinfection will terminate in a prognostically more or less favorable development than an identical infection in a normal, non-infected animal. Such knowledge has caused an association between allergy and immunity which is undoubtedly much closer in the interpreting mind than in reality.

But without entering further into this much discussed theoretical phase, it must be apparent at once that all the factors that decide the outcome of an allergic phase (dosage, virulence, time interval, location) are totally uncontrollable and unanalyzable in clinical work. Therefore, no parallelism can be apparent between the allergic state of a patient and his immunity or resistance. Empirical observation confirms this theoretical conclusion: neither tuberculin tests (i.e. an intentional test for the allergic state), nor spontaneous allergic reactions permit of any judgment of the patient's immunological condition, or, in other words, of the prognosis.

The morphological characters of allergic reactions, pathological, roentgenological, and—to a limited extent—clinical, are fairly well established. Pathologically, they are represented in the lung as quickly developing, more or less circumscribed exudative foci which are in all essential respects not much different from banal bronchopneumonias. It is not pertinent here to discuss the differentiating details; the main fact of practical importance is their exudative character. The potentialities of their further development are: complete absorption,

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caseation and excavation, and more or less complete fibrosis at any stage of the development. Their appearance, their absorption and their excavation proceeds at times with great speed, a general characteristic of allergic reactions.

Roentgenologically, allergic reactions produce focal areas of slight or medium density, usually fairly homogeneous in structure and with blurred, unsharp outlines which gradually fade out toward the normal parenchyma. Since such lesions may occur under a great variety of circumstances their more detailed characteristics cannot be given here with more precision.

The clinical manifestations, polymorphous to an extreme, will better be mentioned with the later more special discussion.

Such allergic phenomena appear with fair regularity at certain definite stages of the disease: (1) at the clinical onset; (2) as exacerbations of old foci; (3) at the initiation of new foci by bronchogenic spread, and (4) as terminal lower lobe pneumonias, so frequently diagnosed wrongly as non-specific pneumonias.

(1) *Clinical Inception.** The most characteristic type of onset is the appearance of a single area of infiltration, usually more or less rounded, 2 to 5 cm. in diameter. Its localization is most frequent in the peripheral parts of the upper lobe, at the height of the second to third ribs; it is but rarely seen in the apex proper. It is, however, not rare to find it in the mid-lung field, particularly in the apex of the lower lobe. This latter localization is often misinterpreted as "hilar region," especially when no stereoscopic films are taken. The localization in the true hilar region is extremely rare. Basal foci occur and constitute particularly difficult differential diagnostic problems. The lesion here described is the *Frühinfiltrat* of the German literature; but its synonym "infraclavicular infiltration" should, as an obvious misnomer, disappear

from medical usage. Roentgenologically, the etiological diagnosis is almost impossible. Any banal bronchopneumonia may have the identical appearance. Slight density and localization in the upper lobes speak somewhat in favor of tuberculosis.

In some cases the roentgenologically demonstrable onset is preceded by a long history of symptoms suggestive of tuberculosis, fatigue, loss of weight and muscular tone, and slight elevations of temperature. It is still a matter for speculation whether such preceding symptoms are caused by an undetectable tuberculous focus, or by a non-tuberculous disorder which prepared the soil for tuberculosis. In some other cases, subjective symptoms are almost or totally absent. The majority of patients, however, exhibit a symptomatology which is characteristic enough, although totally different from what is still taught to be the characteristic syndrome of incipient tuberculosis. The onset is sudden, though frequently not acute in the sense of severe; it is marked by the symptoms of a "heavy cold" or a slight "flu" without particular emphasis on respiratory symptoms. There is a moderate elevation of temperature of a few days' duration, although slight subfebrile temperatures may continue for a long time. The general well-being is not much disturbed, but the return to a completely normal level is unduly delayed. Altogether the patient with a small initial tuberculous bronchopneumonia feels and looks less ill than the patient with a comparable non-tuberculous bronchopneumonia. This discrepancy between marked roentgenological findings and the paucity of clinical signs and symptoms is probably the most important differential diagnostic point. Similarly, the blood picture is less disturbed in tuberculosis, the total white count hovers usually near or slightly above the upper limits of normal, there is no or slight neutrophilia, no or slight shift to the left, and toxic changes in the leucocytes are almost always absent. The local physical signs do not contribute to the differential diagnosis, although complete absence

* When this paper was presented it was illustrated by lantern slides of chest roentgenograms of representative cases. For purposes of publication it seemed advisable to omit individual case reports and to emphasize more the general features.

is more frequent in tuberculosis. The later developments are not under discussion here; they may produce roentgenological pictures that are practically diagnostic (cavitation, fibrosis); but it should be kept in mind that rather rapid clearing is no argument against the diagnosis of tuberculosis. In the very earliest phases, sputum and bacilli may be absent, but they may appear during the period of absorption.

Another, but much less frequent, type of onset is characterized by the sudden appearance of a massive, at times lobar, infiltration. These cases are at the onset almost invariably diagnosed as lobar pneumonia roentgenologically; and, indeed, there is nothing to differentiate the two diseases by the roentgen ray. But these patients exhibit still more strikingly the discrepancy between anatomical involvement and symptomatology. This usually permits of making the diagnosis before tubercle bacilli are found in the sputum, ordinarily an early occurrence. It will be good to remember that labial herpes is excessively rare in uncomplicated tuberculosis.

A third type of onset, frequently puzzling to the roentgenologist, shows many widely scattered, fluffy, roundish shadows. They are usually ill defined, of slight density and homogeneous. Often, the distribution is fairly symmetrical and more dense in the upper portions. The size of the individual shadows may be fairly uniform or may vary greatly. When all shadows are fairly large, say 1 to 3 cm. in diameter, the picture is quite similar to the one produced by multiple tumor metastases, especially from a hypernephroma. When all the shadows are small, the picture may simulate pneumoconiosis. The clinical features of such cases—most likely due to hematogenous seeding—need a good deal more study. However, these patients, too, show at times an appalling paucity of symptoms compared with their extensive involvement. Not infrequently, such patients make a rather unexpected recovery, associated roentgenologically by apparently complete clearing, by

fibrosis or by calcification. Unless excavation develops, the sputum is always scanty and tubercle bacilli are rare. (A special study of this type of non-miliary hematogenous pulmonary tuberculosis will be presented in the near future.)

The three roentgenological manifestations mentioned: isolated infiltrations, massive, sometimes lobar infiltrations and multiple, probably hematogenous infiltrations, account probably for the vast majority of all cases of pulmonary tuberculosis in the adult as far as the clinically and roentgenologically initial lesion is concerned.

(2) *Exacerbations of Old Foci.* Old, more or less healed tuberculous foci, make the roentgenological manifestations of more or less extensive areas of fibrosis or calcification. There is, however, little doubt that anatomical scars of tuberculous foci may escape roentgenological detection, either by virtue of their location (mediastinal or diaphragmatic shadow) or by virtue of their size. The radiopacity of fibrotic scars may be compensated by circumfocal emphysema. Exacerbations of old foci manifest themselves roentgenologically as fluffy, ill-defined shadows surrounding old foci: circumfocal infiltrations. They develop within the course of a few days, usually accompanied by symptoms and signs similar to the ones seen at the clinical onset of the disease. These infiltrations may promptly absorb. In other cases they are the inception of a period of active and progressive disease; and then the infiltrations undergo the same progressive changes as do initial foci.

From a standpoint of prevention and prognosis it would be important to know what type of old foci are more or less likely to undergo exacerbations. Nothing very definite is known about this question, but a few empirical impressions may be mentioned. Exacerbations seem to be quite rare around isolated, calcified primary foci (Ghon tubercles), especially in adults. They are relatively frequent around multiple calcified foci, the residues of non-miliary hematogenous pulmonary tuberculosis men-

tioned above. The characteristic process is the appearance of thin perifocal shadows simultaneously around a number or all calcified foci present. This is apt to initiate rapid progressive destruction with the formation of large cavities. Strictly apical foci, fibrotic or calcified, seem to exacerbate much less frequently than subapical foci. In general, the impression is gained that the likelihood of exacerbations decreases with increasing age of the patient. These are a few principles based on roentgenological evidence. Needless to say that the likelihood of exacerbations depends largely on the clinical status of the patient.

(3) *Bronchogenic Metastases*. In the course of an active pulmonary tuberculosis new territory is frequently invaded by bronchogenic spread. Invasion of previously normal parenchyma is, as a rule, manifested by an acute infiltrative lesion of the same type and of the same potentialities as initial infiltrative lesions. Since they are added to the background of an already existing disease they are not infrequently overlooked. Their roentgenological characteristics are essentially similar to initial foci; often they are fairly large and may consist of coalescing clusters of shadows. In rare instances they occur without any associated symptoms; frequently the symptoms, when not checked up by roentgen studies, are interpreted as a "cold."

(4) *Terminal Bronchopneumonias*. Probably the most frequent single direct cause of death in pulmonary tuberculosis is massive bronchogenic spread in the lower parts of the lung. This process is frequently diagnosed as non-tuberculous pneumonia. The roentgenological manifestation of this process is a massive infiltrative lesion, usually unilateral, at times bilateral. The internal structure of the shadow shows often a cloud-like unevenness, suggesting multiple centers of dense (probably caseous) infiltration surrounded by less opaque exuda-

tion. The significance of such a lesion lies in its finality and not in any therapeutic consideration.

SUMMARY AND CONCLUSIONS

The important landmarks in the progression of pulmonary tuberculosis are signalized by acute exudative lesions whose pathological bases are tuberculous bronchopneumonias. Roentgenologically they are manifested by the characteristic shadows produced by exudative lesions. Their appearance should more often than is the case today suggest the diagnosis of tuberculosis, although these shadows *per se* are not pathognomonic of tuberculosis. In conjunction with the clinical and laboratory findings the diagnosis is usually made without much difficulty. But it should be emphasized that without roentgenological studies a vast number of such lesions will remain undiagnosed and even unsuspected.

Whenever uninvolved pulmonary tissue is invaded by tubercle bacilli the tissue responds by acute infiltrative reactions; hence their appearance at the clinical onset of the disease (in previously infected individuals), at new focalizations and at exacerbations. These allergic reactions contain all the potentialities of complete resorption, progressive destruction and healing by fibrosis or (in some cases) by calcification. The prognosis at the onset of each such reaction must be guarded, but the possibility of definitely benign developments should not be underrated. Even if the final course is progression, the immediate development is often regressive. This explains the apparent paradox that the exquisitely chronic course of tuberculosis is composed of a series of acute phases. Most of the acute phases are followed by periods of retrogression and partial repair; and these intervening periods lend to the disease its chronic nature.

PUBLIC HEALTH AND TUBERCULOSIS*

By HENRY F. VAUGHAN, DR.P.H.

Commissioner of Health

DETROIT, MICHIGAN

YOU have, as roentgen-ray experts, been looking at the tuberculosis problem from a rather short distance. We wish to take you away from that near aspect temporarily and have you look at it from the broader community viewpoint.

Your President, Dr. Evans, has indicated that the roentgen ray is one of the most important implements for finding the early case of tuberculosis. What is true of tuberculosis is equally true of another disease which now ranks among the leading and most important causes of death, cancer. Although the tuberculosis death rate has declined during the last two or three decades in a very startling fashion, this disease is still one of our most important single causes of death. Cancer is rapidly nearing the top of the list. There are no two diseases in which health departments are now more interested and in which the roentgenologist plays such an important part. At this time with critical financial conditions confronting all health departments, not to mention the physician in private practice, there is greater need than ever before for cooperation and integration of all existing health machinery in each community. By health machinery we mean the public which is really the beneficiary of any action; the medical profession, dental profession, and the public health agencies, whether of an official or non-official character.

We have had some experience in Detroit with such a cooperative plan during the past several years. We visualized a situation wherein there are some 1,500 practitioners of medicine and one health department, and it occurred to us that the 1,500 physicians could do far more to preserve the public health than could a single health department. If we could bring together the

facilities of these two organizations we could expect great results.

There is nothing more irritating to the average physician than a free clinic operated by a health department. So we started out, in cooperation with the Wayne County Medical Society some six years ago, to do away with free clinics and substitute an interest on the part of the practicing physician in preventive as well as curative medicine. If we could have 1,500 health centers in Detroit instead of the few which the health department could support, how much better it would be for the public. Instead of going to free clinics, our people would go to the office of one of the cooperating physicians for prophylactic services; immunization against diphtheria, vaccination for smallpox, the annual health examination, the early diagnosis of tuberculosis and cancer. There are other diseases which are not primarily the concern of the health department since they are not communicable, but offer problems in which the health department is becoming more and more interested because of the high mortality.

A program of diphtheria prevention was agreed upon as our first objective. We closed all our free immunization clinics. There has been no free clinic for diphtheria protection for over three years, and yet we feel sure that there is no large city in the United States which by actual count has a higher percentage of its children protected against diphtheria. All the immunizations are given in the office of the family physician, or the cooperating physician. We have an agreement with each individual physician that if on certain days at certain hours the parent presents himself with the child, the doctor will give a definite service for a certain specified fee. The fee was set

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

by the medical society. If the parent comes to the office at this hour toxin-antitoxin or toxoid is given for \$1.00 a dose, \$3.00 for three doses, or for nothing if in the physician's judgment the parent cannot pay. The health department reimburses the physician for those who cannot afford to pay, at the rate of 50¢ per dose, or \$1.50 for three doses. We also pay \$1.00 for the Schick test.

This plan has functioned for three years, and we now have 77 per cent of our school children and 43 per cent of our preschool children immunized against diphtheria, without free clinics. Not a dose of toxin-antitoxin has been given by the health department. One of the criticisms of the plan has been that of expense. Some health officers say that it is too expensive, but let me set you at ease in that regard. In no year has the whole program, including sums paid physicians plus the expenditure for the immunizing agent, equalled the previous cost of treating cases of diphtheria in our own hospital. The diphtheria death rate has been cut in four. During the past three years the physicians of Detroit have lost \$60,000.00 because of the reduction in the diphtheria death rate. During these same three years the physicians have been paid either by parents or by the Health Department \$325,000.00 for their services. In other words, preventive medicine has paid the physician more than curative medicine in the ratio of five to one. The average cost of treating a case of diphtheria is \$35.00. The average cost of prevention is \$3.00. Therefore, the parent has gained in the ratio of more than ten to one. We have, above all things, created an atmosphere, a thought of preventive medicine in the office of the average medical practitioner, so that the doctor is now thinking in terms of preventive medicine and not merely in terms of curative medicine.

We have made no particular effort to secure vaccination against smallpox other than to encourage it wherever possible. The percentage of preschool children vaccinated against smallpox has increased from 22 to

43. There have been no funds to pay the physician for this service. He should be paid. We believe it is a basic and important principle that a physician should be paid for his services. In the past, physicians have done too much for nothing. It is largely their own fault. You do not find the legal profession doing likewise. If a man without funds is caught in the toils of the law, the court appoints a lawyer and the state pays the lawyer; but if a doctor takes care of an indigent case the doctor usually is not paid. We feel that it is important that the physician should be paid at least a small honorarium for his service.

Last May, we made a beginning in applying the plan of medical participation to the control of tuberculosis. The most important tools for finding the early case of childhood tuberculosis are the tuberculin test and roentgen examination of the chest.

Year after year we have urged, in our annual tuberculosis case finding campaign, that parents take their children to the family physician. At the same time we have had free clinics in public buildings, and tuberculin surveys in the public schools. Last spring we decided to follow our other program, and during the months of April and May we urged, through a very definite program of education, that the parents take their children not to a clinic but to the family physician for a tuberculin test. During those two months, 5,000 parents in Detroit took their children of school age to their family physician for the tuberculin test.

We had built up a group of cooperating physicians. We had correlated the work with the local roentgen society so that the roentgenologists cooperated. We do not know, unfortunately, how many roentgen examinations were made. Our record system was incomplete. We report these results merely as a beginning, as a healthy indication that you can educate the public to the viewpoint of going to the physician for a preventive service in tuberculosis, for a tuberculin test, and for a roentgen examination.

We must mention one important part of our program, that is, our postgraduate course for physicians. When we started our diphtheria work we found some physicians who did not know the difference between toxin-antitoxin and antitoxin. In fact, a few gave antitoxin for immunization. We instituted a postgraduate course in communicable diseases. During the first year one-third of the membership of the county medical society attended a course of instruction in communicable disease control, a course consisting of an hour's lecture given once a week. The interest was gratifying. Last year a similar course in tuberculosis case finding was conducted. It is essential that the medical profession be prepared before the public is prepared.

We are reminded of an interview with a physician who visited the Health Department and who did not believe in giving antitoxin in the treatment of diphtheria. After arguing for some time and offering a series of laboratory experiments, we finally inquired in despair, "Where in the world did you graduate in medicine?" He said, "It might interest you to know that I was a student of your father's at the University of Michigan." We further inquired, "In what year did you graduate?" He replied, "I graduated in 1890."

The only trouble with this gentleman was that he graduated two years before Roux gave the world antitoxin, and he was still practicing the medicine of the vintage of 1890. Unfortunately, there are a few physicians of that character.

Those physicians who are wont to attend medical meetings with regularity will cooperate in a program of preventive medicine, but the physician who must be reached is the one who never goes to any medical meeting. Consequently, we employed a medical coordinator who went around and visited such physicians in their own offices and prepared them to practice preventive medicine.

We believe that this program of medical participation in public health work is applicable to tuberculosis control. We would never subscribe to a program of drastic revolutionary character. We do, however, subscribe to a program of education and evolution whereby the need for the free clinic will be largely minimized. Clinics serve a useful purpose as teaching centers and as a means of demonstrating the efficacy of control procedure. We believe that much of the service now rendered to indigent patients in clinics and dispensaries can gradually be transferred to the prepared physician in his own office.



THE VALUE OF THE ROENTGEN RAY IN APPARENTLY HEALTHY CHILDREN OF SCHOOL AGE*

By D. S. BRACHMAN, M.D.

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THE case-finding program, as described to you by Dr. Vaughan, can be divided into two parts: first, the diagnosis of tuberculosis in patients having symptoms, with examination of contacts; second, work on a large scale on the apparently healthy. Our program for case finding is one that deals entirely with the latter group. It is, therefore, supplementary to and not a substitute for the usual method employed until recently.

Some very interesting facts were elicited in a study of 35,000 school children, of which 9,000 were of high school age. In one of the high schools we found 14 cases of adult type tuberculosis, which was 1 per cent of the enrollment. General development was good or fair in all but 4 cases. Definite symptoms of disease were found in only 3, a fourth student having a "cold" for one week only. As to physical signs, in only 2 was the evidence of disease definitely apparent, while in 2 others there were slight signs ordinarily calling for further investigation. Another outstanding fact elicited was that only one of the 14 students had a contact history. Thus, in the previously employed program of tuberculosis prevention only one of the 14 children would have been investigated.

The findings in this group, as well as those in the other schools, were then divided according to their various houses or home rooms, as they are often called. It is according to such a classification chiefly that contact can be considered, for in all other groupings the contact is comparatively slight and particularly complicated, there being as many as 100 class rooms in one of the schools studied.

Going further into those 14 cases there was one girl, sixteen years of age, who had a very markedly advanced lesion in the

left lung; in fact, the whole lung was tuberculous. She was well nourished and developed. She played on two of the school teams, and did not have the faintest idea there was anything the matter with her. In her case, of course, the physical examination showed very definite pathological signs.

Taking some 24 rooms that were investigated in these high schools we did not find more than 2 in any home room except the one in which this girl was found, and in which 7 cases of adult type disease were discovered. After careful consideration of all factors, we came to the definite conclusion that one girl gave tuberculosis to at least 5 other girls in her home room. In other words, we are faced today with definite information that in the school systems of the various large cities where large numbers of children congregate day after day, we will find a definite source of contact, an innocent source, if you like, because not more than 3 of those 14 children had any idea they were ill and, therefore, they could not have taken the proper care of themselves.

The results of the investigation of the 35,000 children showed that adult type tuberculosis occurred only occasionally in the grade school children. Taking all the high school children, however, the general average was 0.5 per cent, or one in 200; 4.9 per cent had childhood type tuberculosis, and 1.5 per cent were suspects.

We suggest where work is being done in tuberculosis among the apparently healthy children, that the initial program be started with the high school age. Though the percentage of adult type in the lower grades is very low, the percentage of childhood type is rather high, and because the childhood type is the potential adult type of high

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

school or later years, it is strongly advisable where finances make it possible that all the school enrollment be included in the investigation.

All the open-air schools in Detroit are used for childhood type tuberculosis. It is apparent that in that way the physicians and the Department of Health can carefully check up on this group, and as found necessary, exclude them from school, whereas if they were all excluded a large number would be unnecessarily hampered and certainly their parents would be frightened.

All children should be tuberculin tested and the reactors examined roentgenologically. We feel definitely satisfied that in no other way is it possible to diagnose all of the adult type tuberculosis at its beginning. No other method answers the purpose. We have found that out very conclusively.

In closing, I would like to suggest one

thing. Before you make a final diagnosis even where you see a definite childhood type and what looks like an infiltration of the lung, I suggest that you re-examine the child by roentgen ray, if the lesion is very small, in approximately ten days to two weeks, because we have discovered that what apparently looks like a definite adult type involvement sometimes turns out to be a pneumonic process. I am certain all of you run into that but because of the severity of the after-treatment following the diagnosis of tuberculosis, we feel it is advisable not to take the diagnosis by roentgen ray too lightly. In our discussions with the physicians and the health workers, we always emphasize that the roentgenologist should be given an opportunity to check up if necessary; that when he desires to check up it is for the interest of the patient rather than, as some think, a matter of personal gain.



THE IMPORTANCE OF THE ROENTGEN EXAMINATION IN THE MODERN TREATMENT OF PULMONARY TUBERCULOSIS*

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IT IS now quite generally recognized that the roentgen ray is the most accurate means at our command for the diagnosis of pulmonary lesions of all sorts and pulmonary tuberculosis in particular. It may be, however, that the place of the roentgen ray in following the course of disease and the progress of treatment in pulmonary tuberculosis is not so well understood.

It is not sufficient simply to make a diagnosis of pulmonary tuberculosis, any more than it is enough to tell the patient that he needs rest, and let diagnosis and treatment go at that. Pulmonary tuberculosis must be amplified in its diagnosis both upon a quantitative and a qualitative basis. To explain what is meant: A quantitative diagnosis must indicate the part of the lung involved and the extent of the involvement, which may well be put into the terms of the usual classification of minimal, moderately advanced, far advanced, and childhood type. The next step, however, may not be so readily apparent, namely, the making of a qualitative diagnosis, by which is meant a more careful analysis of the type of lesion found, as to whether it is exudative, productive, or a mixed lesion with both exudative and productive elements present. If cavities are present, the qualitative diagnosis should include a description not only of their size and location, but also their type. Pinner has made a very useful classification for this purpose which lends itself to practical application. In this classification, there are three types: (1) the small, multiple cavities in densely infiltrated parenchyma, frequently referred to as "moth eaten," (2) round or oval, thin-walled cavities and (3) irregularly shaped cavities with thick walls.

Such a diagnosis as that just outlined depends on the roentgen ray and can be accurately made only with its aid. Having made such a diagnosis, it is possible then to determine the proper measures of treatment to employ, and to follow the course of treatment, noting the success attained and whether or not it may be necessary to add other procedures.

The treatment of pulmonary tuberculosis is still based upon the fundamental concept that rest to the injured or diseased part is the best aid to healing, but whereas a few years ago rest in bed was the only means generally employed for this purpose, more recently collapse therapy has been added to the armamentarium of the phthisiotherapist. The addition of this means of treatment is the biggest single advance yet made in the control of tuberculosis. With the aid of collapse therapy it is possible to treat the individual case more successfully and restore the patient to health. The prompt closure of cavities, and resultant cutting off of sputum containing tubercle bacilli, is a most effective check to the spread of the infection in the community.

Collapse therapy is the general term applied to such procedures as paralysis of the diaphragm produced by surgery upon the phrenic nerve, artificial pneumothorax, and thoracoplasty surgery, together with several additional procedures less widely employed but all depending upon the principle of either temporarily or permanently relaxing the lung by lessening the space it must occupy. Actual compression of the lung is used at times but far more frequently simple relaxation, by allowing collapse of the expanded lung, without compression, is employed. Any procedure pro-

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept 27-30, 1932.

ducing either simple relaxation or actual compression comes under the general heading of collapse therapy.

Minimal pulmonary tuberculosis, without some evidence of cavity formation present in the lung, does not account for a very large number of cases among all those presenting themselves for treatment. While it is most desirable to discover the presence of pulmonary tuberculosis before cavitation has occurred, still the fact remains that most patients when discovered to have the disease, do have evidence of cavity formation.

It is not necessary to point out, other than to mention, that the presence of cavity in the lung is of grave significance. Graef in 1921 made the statement that the presence of cavity in pulmonary tuberculosis sounded the death-knell of the bearer. In the main, this is a pronouncement open to little question. However, if cavities can be closed, it is now known that recovery can be made in a large number of cases. Collapse therapy offers such a means of controlling the cavity and saving the patient.

Another factor that is not often considered is that cavity formation is not a late manifestation, but occurs early in the disease—indeed it may be said to be an acute process. It has been found, for instance, in a study at the William H. Maybury Sanatorium, that in a group of 119 patients who had an acute onset of their disease and in whom the symptoms had

been present for six months or less, there were 86, or 72.2 per cent, who had evidence of cavity formation.

It was further noted that in similar groups of longer duration, where the onset was acute, the percentage of cavity-bearers did not increase, but remained essentially the same, regardless of duration of the disease when first seen. (A table from this study will more clearly illustrate this point.)

It is true that cavities do heal spontaneously under a simple bed rest regimen, but it is also true that this favorable outcome is so unusual as to be remarkable. In fact, it is recognized by most of those who have studied tuberculosis carefully that most cavities show little tendency to close spontaneously. On the other hand, the addition of collapse therapy will close many cavities promptly, and start others on a slow but steady progress toward closure. The fact that it can be demonstrated that cavities will close promptly after collapse measures are employed is in itself sufficient reason for employing these procedures promptly, without taking the risk of the cavity becoming larger and more serious because of older and more rigid walls.

Realizing, then, the seriousness of cavitation and the rapidity with which cavities may form, there need be no other argument brought out for the prompt institution of collapse therapy for the control of this menace to the patient.

It has repeatedly been shown that physi-

RELATION OF COURSE OF DISEASE TO PRESENCE OF CAVITIES AND DURATION OF SYMPTOMS

Duration of Symptoms	Sudden Onset			Insidious Course		
	No. of Patients	Cavities Present		No. of Patients	Cavities Present	
		No.	Per cent		No.	Per cent
6 months and less	119	86	72.2	31	12	38.7
More than 6 mo. to 2 yr.	134	93	70.0	45	29	64.4
More than 2 to 5 yr.	38	26	68.4	27	13	48.7
More than 5 yr.	25	19	76.0	15	9	60.0
Total	316	224	70.8	118	63	53.4
Average duration of symptoms	1.63 years			2.64 years		

cal examination of the chest will not give the information desired, and that only by roentgen examination can the lesion be accurately enough visualized to be the basis for establishing proper collapse measures. Again, serial roentgenograms taken at suitable intervals will determine the effectiveness of the treatment instituted and whether any additional procedure is needed to produce the proper collapse. If, for instance, it is found that there is a recent exudative lesion with multiple small cavities present, and limited to less than moderately advanced extent in one lung, a phrenicectomy may give sufficient collapse to bring about healing. If closure of the cavities and negative sputum do not result promptly—say in three to four months—which condition, of course, can be determined only by taking a roentgenogram, it will be necessary to add pneumothorax to bring about more complete collapse. It is always well to corroborate the completeness of the collapse by the absence of tubercle bacilli in the sputum for, if the roentgenogram indicates no cavity and the sputum is negative for tubercle bacilli after careful search, the evidence is well established that closure has occurred.

Artificial pneumothorax, to be successfully carried out, must be carefully followed with suitable visualization. A film should be taken every two or three months. Furthermore, it is most advisable to use the roentgenoscope before and after each refill, which will make for greater safety and will acquaint the operator at all times with just how satisfactory the collapse is, whether fluid has formed, the space is being lost, or if adhesions may be defeating a successful result.

The course of pneumothorax treatment must be watched most carefully, for, in addition to those complications already mentioned, shifting mediastinum and the effects of various pressures on the degree of collapse must be observed. By careful roentgen examination it can be determined whether adhesions, when present, should be cut to bring about better collapse. It will also be necessary to determine the

adhesions that it may be possible to cut, and from their size to judge how best to cut them: by the Jacobeus method of cautery, with thoracoscopic observation; or the direct observation method of O'Brien, in which clamping and cutting is done through a small incision in the costal periosteum after resecting a small portion of rib. These and other modifications of pneumothorax must be undertaken only after most careful visualization with the roentgen film and the fluoroscope.

It would be impossible to carry on such treatment satisfactorily without the aid of the roentgen ray. It is true that artificial pneumothorax was employed as a therapeutic measure in pulmonary tuberculosis before visualization by the roentgen ray came into use but, while there were some striking results, the inability of the operator to know with any exactness the state of the lungs, resulted in this form of treatment being little used and even abandoned for several years. Murphy and Tice used artificial pneumothorax in Chicago in the '90's but gave it up even though they felt it was a valuable measure. With the widespread use of the roentgen ray which has taken place in more recent years, pneumothorax has come into its true place as a most valuable aid in producing arrest in pulmonary tuberculosis.

The roentgen ray is important in deciding upon various thoracoplasty procedures, to learn as exactly as possible the condition of the lung to be collapsed in order to determine the amount of surgery to employ. It is also necessary to know the condition and functioning capacity of the better lung as deduced from the roentgenogram.

It must be readily apparent that to attempt to follow the course of treatment with any form of therapy in pulmonary tuberculosis by physical examination, without the roentgen ray, would be out of the question. The better understanding of the nature of pulmonary tuberculosis, and the ability to visualize the lesions and what may happen to them under treatment, made possible by roentgenology, has allowed the

use of collapse therapy. Indeed the roentgen ray has made collapse therapy possible and, instead of the cavity being the death-knell of its bearer, many are saved by prompt application of one or more of the collapse measures available.

This symposium surely will make clear the fact that collapse therapy is the biggest advance yet made in the treatment of pulmonary tuberculosis, and it is readily apparent that its success is based on careful use of the roentgen ray both for complete diagnosis and the check on results obtained during the course of treatment.

SUMMARY

1. The roentgen examination provides the information for a quantitative and qualitative diagnosis in pulmonary tuberculosis.
2. The cavity in tuberculosis signifies a most serious prognosis.
3. Collapse therapy will serve to close many cavities and thereby convert a grave prognosis into a favorable one.
4. The proper application of collapse therapy depends upon accurate visualization by means of the roentgen examination.



ARTIFICIAL PNEUMOTHORAX IN A GROUP OF CASES OF PULMONARY TUBERCULOSIS FORMERLY LOOKED UPON AS HOPELESS*

By RICHARD MORGAN, M.D.
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AN EXTENSIVE literature dealing with artificial pneumothorax has accumulated in the past few years. The use of the method in the treatment of pulmonary tuberculosis long ago ceased to be in any way experimental and is today accepted, as Rist of Paris, has stated, as the greatest advance in the treatment of tuberculosis since the advent of the so-called rest cure. Much has been written concerning the technique of the procedure. It will be unnecessary to mention that in this paper. The indications for instituting a pneumothorax would make a long chapter and cannot be covered here. The chief purpose of this paper is to briefly point out its applicability in quite a large group of cases in the past generally looked upon as hopeless and for whom no treatment other than prolonged and generally futile bed rest was prescribed.

Most of these cases are moderately or far advanced with disease predominantly in one lung; cavity or cavities are recognized in the lesion and have been responsible for bronchogenic spreads into the opposite lung, where already there may be evidence of excavation. Are we to deny this large group a chance of recovery, or at least marked improvement? We know full well the fate of most patients who have progressed to the stage of cavity formation—continuously positive sputum with resulting bronchogenic spread of disease into the formerly uninvolved lung.

Our experience in the treatment of this general class has been so encouraging that we have come to feel that most of them should be given a chance through some form of collapse therapy.

We may do a pneumothorax on the most advanced side, watching the lesion in the opposite lung with an idea of instituting

treatment promptly if needed; often we will note a prompt and favorable clearing of the lesion in the contralateral lung which continues to the point of satisfactory fibrosis of the lesion. If the lesion appears to progress a pneumothorax may be begun at once, or if the lesion is not too advanced a temporary paralysis of the diaphragm on that side may be produced, holding pneumothorax in reserve for further chance to observe the behavior of the disease. It will happen in some cases that a quite definite cavity in the contralateral lung will be seen to close soon after instituting a collapse on the opposite side.

We were for many years warned about establishing a collapse where a lesion could be recognized in the contralateral lung. We took it for granted that the contralateral lung would suffer from the added work imposed upon it while the diseased lung was under collapse treatment. Gradually as we have attempted treatment in cases which were bilateral we have been impressed by the manner in which lesions in the opposite lung cleared under treatment of the more involved side. We were inclined years ago to ascribe this to the general improvement in the condition of the patient brought about by closing up the badly diseased lung. Today we are inclined to a very different explanation. It is not the occasional case that demonstrates a clearing of the lesion in the contralateral lung. In our experience it is seen to result in the large majority of them. The result is that a formerly hopeless group are now being offered treatment which was in years past denied them.

Confronted with bilateral disease we have two chief factors to consider. First, is there enough normal lung tissue to warrant

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

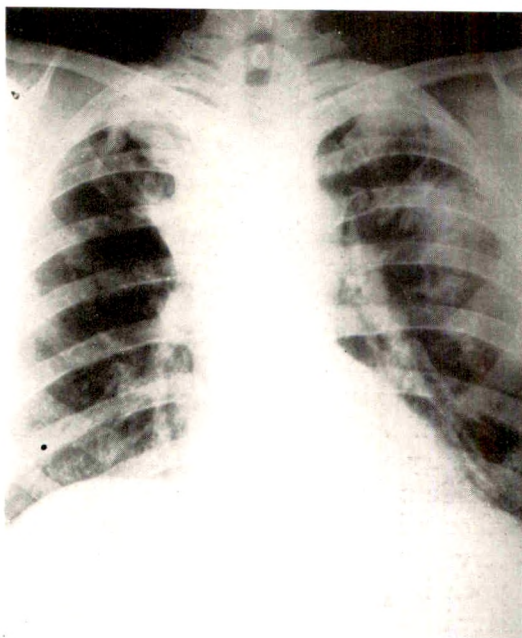


FIG. 1. Case 1. Adult male, aged forty, admitted with moderately severe hemoptysis of two weeks' duration, bleeding from left lung; controlled by pneumothorax.

establishing a bilateral pneumothorax? Second, is our patient so ill that he is unlikely to benefit by treatment? A bilateral case running fever, exceedingly toxic and suffering from complicating enteritis or laryngitis, or both, is not likely to respond favorably. Is there noticeable shortness of breath, dyspnea, emphysema? If so, treatment will probably aggravate rather than improve these symptoms. Exceptions even to this could be illustrated. However, if there be sufficient normal lung to enable the patient to carry on, and if he has demonstrated that his disease is being held in check in some degree, we can offer him collapse therapy. If the lesion on one side is advanced and on the other of moderate extent and without clear cut or large cavity, we feel that we can collapse the more advanced side, watching the progress or retrogression of the lesion in the less involved lung. At any time if conditions warrant we must be ready to institute treatment on the opposite side.

The most reasonable explanation of the

favorable effect of collapse treatment noted to take place in the contralateral lung is the lessening of that half of the thorax as a result of a shifting mediastinum. We have seen this happen in a few cases to a surprising extent early in treatment, bringing about so much relaxation of the contralateral lung that the lesion here was markedly favorably influenced in the first few weeks of treatment.

If there is not much choice in the two sides in respect to extent of lesion, degree of cavitation, etc., it will usually be decided to begin a bilateral collapse at once. More times than not one lung *is much more involved than the other*, and in such a case we are apt to begin our collapse on the more advanced side, withholding treatment of the contralateral lung for a month or so to note whether the improvement in this lung will be sufficient to obviate the necessity of a pneumothorax on this side.

We may have a patient with bilateral disease who is bleeding from a more recent spreading lesion opposite from the old

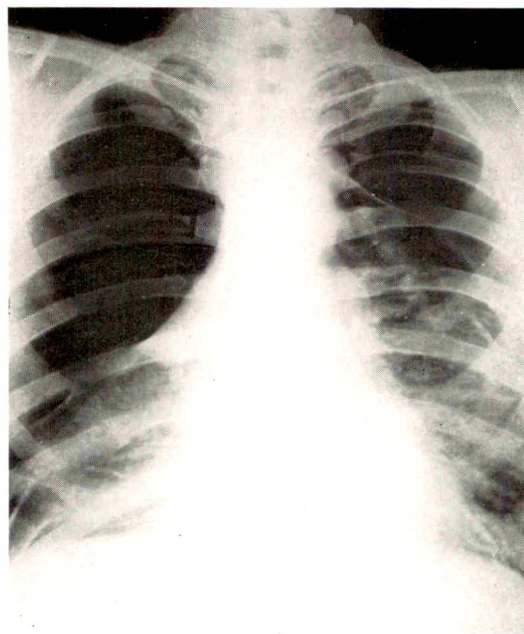


FIG. 2. Case 1. Showing complete control of lesions in both lungs with closure of large cavity in right apex from which there had been a spread of the disease into left lung.

fibrocavernous involvement. In such a case we may be obliged to control the acute symptoms, particularly the hemoptysis, by collapse of this lung. At a later date we can then direct treatment to the old excavated lesion in the opposite lung (see Figs. 1 and 2). We have examples of the benefit of this plan of procedure.

It seems quite proper to mention in this paper a very necessary part of the management of many pneumothorax cases; namely

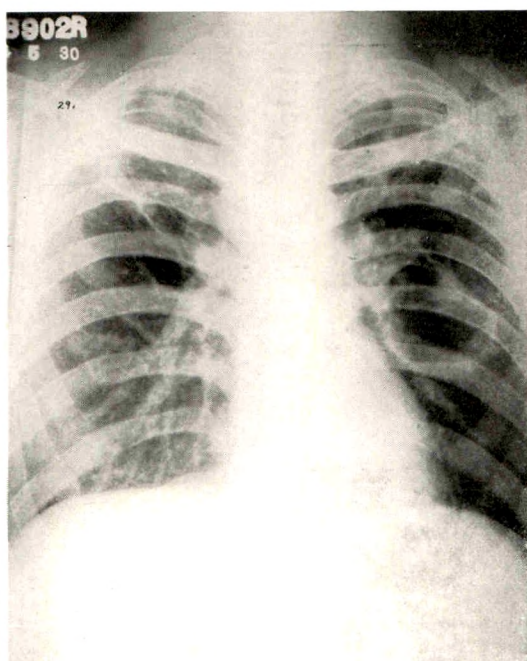


FIG. 3. Case II. Middle aged male, with history of disease for several years, old fibrotic lesion in right apex, with more recent disease in middle of left lung with large cavity; positive sputum.

the adding of a phrenicectomy to assist in the closure of the cavity. Early in some cases, especially if there is a history of recent hemoptysis, we will note that as we proceed with collapse of the lung we will tend to promote hemoptysis. We have thought that the explanation was a pull on adhesions tending to hold open rather than close a cavity.

In several cases the hemoptysis occurred promptly after each treatment, and the addition of paralysis of the diaphragm on

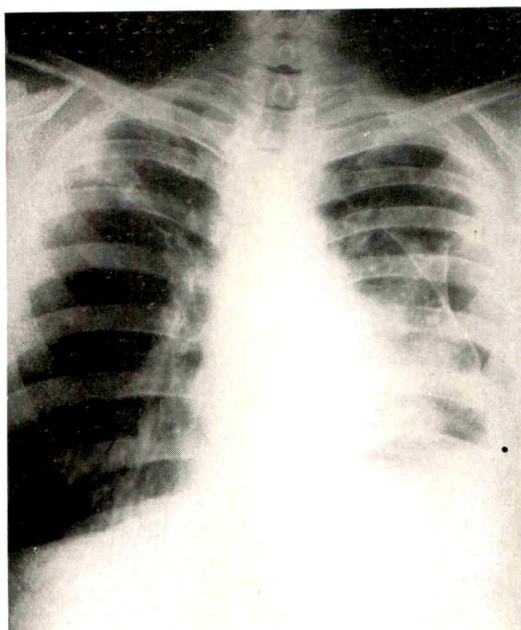


FIG. 4. Case II. Same case after closure of cavity by means of artificial pneumothorax. Phrenic paralysis. Sputum negative for past two years.

the treated side served to relax the adhesions to a degree permitting of suitable splinting of the bleeding area.

In a satisfactory collapse it is expected that the sputum will become negative; a

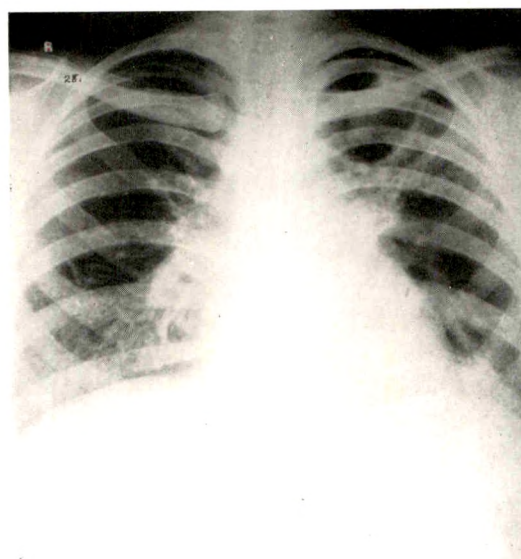


FIG. 5. Case III. Young adult, married female, with large cavity in left upper lobe; positive sputum.

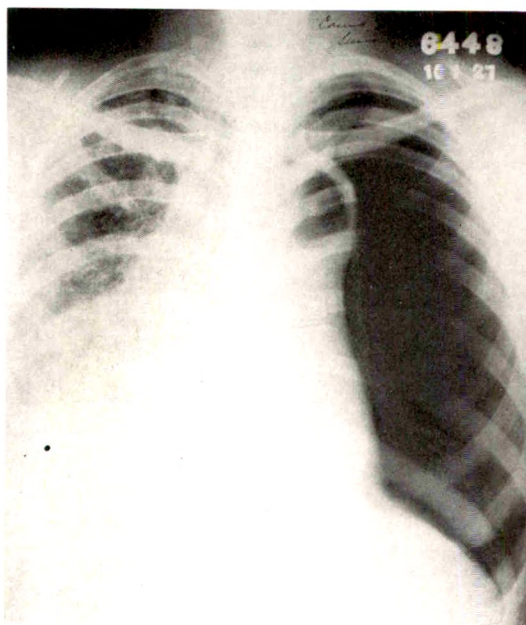


FIG. 6. Case III. Same case with very complete collapse of the lung but cavity still held open and resisting high positive pressures.

persistently *positive* sputum seems reasonable evidence of incomplete closure of cavity. The great majority of our pneumo-

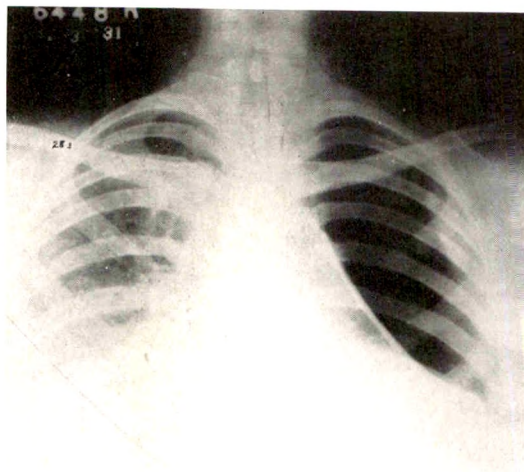


FIG. 7. Case III. Same case approximately two months after phrenicectomy was added. Cavity closed.

thorax cases exhibit a negative sputum within three or four months of the beginning of treatment. If they do not, it is usually because of adhesions holding cavities open, and in such cases we do not hesitate to add a phrenicectomy. The result in many of these is most gratifying and seems sufficient evidence in favor of procedure.

Should we fail to accomplish sufficient relaxation of the adhesions which are preventing proper collapse there is still more that we can offer the patient. We may by

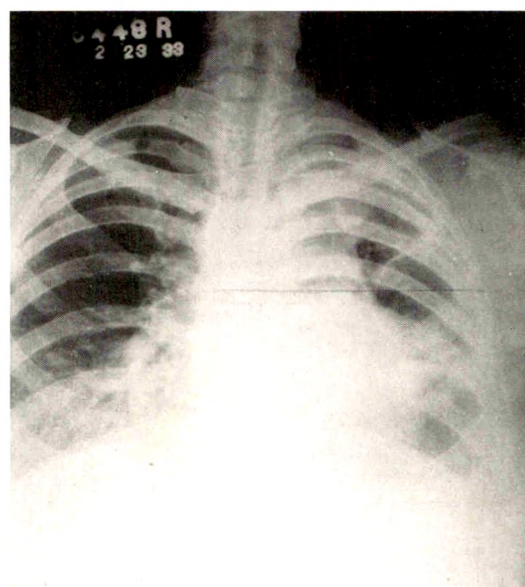


FIG. 8. Case III. After five years of treatment; re-expanded; no cavity; no sputum. Patient has gone through normal pregnancy during treatment.

either the so-called closed or the open method cauterize the pleural adhesions and thereby permit the cavity to close.

The methods mentioned in this brief paper are applicable to either unilateral or bilateral cases and will be dictated by the peculiar situations as they arise.

It may be necessary to abandon a pneumothorax on one side and permit this lung to re-expand with the protection afforded by a phrenicectomy. We may at any time in a previously unilateral case be obliged to begin artificial pneumothorax on the opposite side if a spread occurs in this lung. It

may be required that we aspirate fluid, perhaps repeatedly from one or both sides, but we should not be too easily discouraged because of these necessities.

We have one most interesting case, that of a young girl who came to us with an abandoned pneumothorax on the right side (see Figs. 9, 10 and 11). The pleural cavity here was almost completely filled by a clear, sterile fluid, but in the opposite lung had occurred a severe spread throughout the upper third or one-half with evidence of cavity

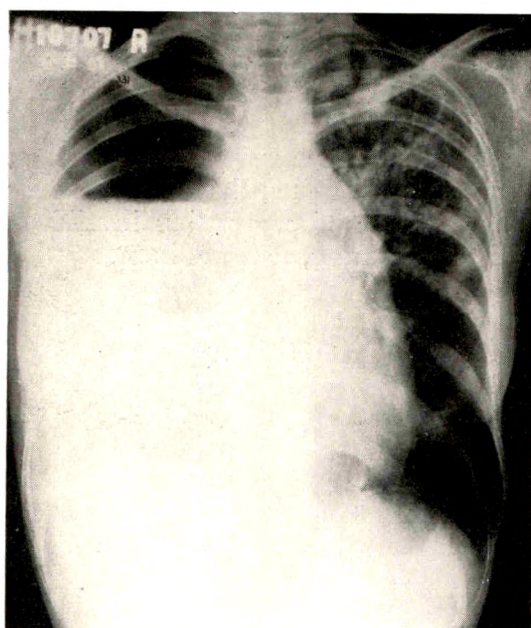


FIG. 9. Case IV. School girl, aged sixteen, admitted with pneumothorax on right, fluid requiring frequent aspiration. Recent excavating disease on the left; considered a hopeless case.

developing. At first it was felt that the outlook was too hopeless to warrant further collapse therapy, but with the advent of streaked sputum we determined to do something. We repeatedly aspirated the fluid on the treated side in order that this lung might re-expand and function should the emergency of real hemoptysis arise in the contralateral lung. As the lung re-expanded its appearance was reasonably satisfactory, and fortunately so, for soon serious bleeding took place in the opposite lung requiring pneumothorax for control.

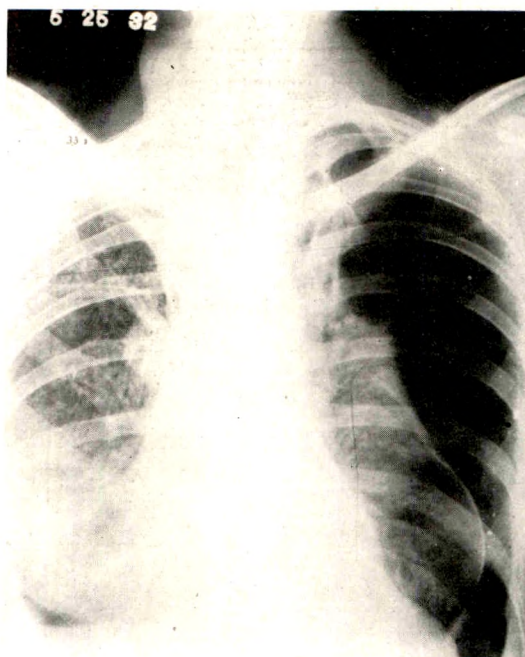


FIG. 10. Case IV. Same case after repeated withdrawal of fluid from the right to permit re-expansion of lung in order that a pneumothorax might be established on the opposite side. Collapse is limited by adhesions and cavity still open.

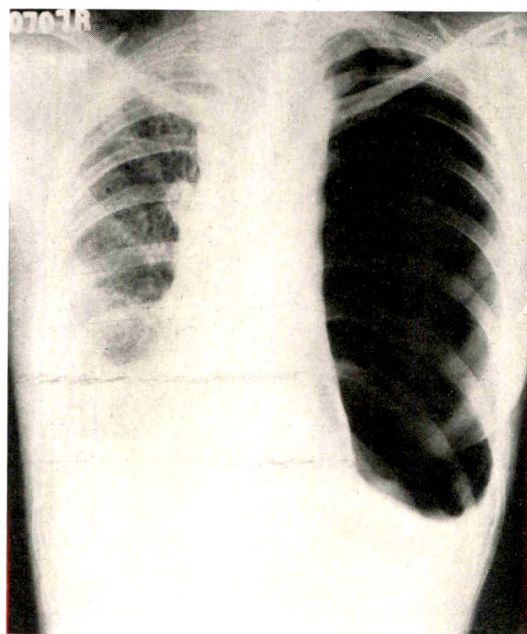


FIG. 11. Case IV. Same case within forty-eight hours after extrapleural pneumolysis. Cavity closed. Cough and sputum completely eliminated.

The collapse here was continued after the emergency had passed, but was soon complicated by large amounts of fluid requiring repeated aspiration. The fluid finally ceased recurring, but we were confronted by several adhesions which prevented closure of a rather large cavity. The sputum continued to be positive, and therefore a phrenicectomy was added in the hope that this would effect closure. Failing in this we decided to sever the adhesions by cauterization and almost at once found the cavity practically closed. Four days after operation the patient stopped coughing and raising sputum.

It is cases of this sort that encourage us to *do something* rather than assign these patients to the uncertainty of bed rest alone. If nothing is done they are in most cases doomed to suffer an early death. If we attempt treatment we will probably bring about a fair recovery in a surprising number of otherwise hopeless cases.

We recognize the additional hazards imposed by bilateral therapy but feel that they are outweighed by the hazards of the disease itself. A spontaneous pneumothorax superimposed upon a therapeutic collapse may be so severe as to cause death. This has been reported in a few instances. Fluid may complicate one or both sides, but as a rule can be handled without difficulty. The cardiac efficiency must be carefully watched and dyspnea given our serious attention. In a patient already dyspneic, it is doubtful whether we should even begin *bilateral* collapse. These cases require most painstaking observation, and yet a large number will reward us for such effort on their behalf. It seems better to offer many of these patients active treatment rather than to subject them to months and months, or perhaps years, of progressing invalidism finally terminating, as it will in most, with death.



COLLAPSE THERAPY IN EARLY MINIMAL LESIONS OF PULMONARY TUBERCULOSIS*

By E. J. O'BRIEN, M.D.

DETROIT, MICHIGAN

THERE could be no place more appropriate for a treatise on the surgical treatment of pulmonary tuberculosis than a meeting of roentgenologists since it is almost entirely upon roentgenological findings that collapse therapy is based. Symptomology, laboratory work, and occasionally the stethoscope, are essential adjuncts, but as the successful treatment of this disease depends, to a large extent, on the detection of early, minimal lesions, as well as on the knowledge of the extent and character of all lesions, we must look to the roentgen ray for our information. No other method of examination will give the necessary data upon which to base intelligent treatment.

Sampson and Brown state that, in early minimal lesions, the stethoscope, in their hands, failed to detect pathology in about 40 per cent of patients, while roentgen examination finds almost 100 per cent. Therefore, if we wait until stethoscopic examination reveals to us that pulmonary disease is present, a large percentage of our patients will be in the moderately or far advanced groups before treatment is instituted. Also, without the assistance of the roentgen ray the character of the lesions, the size of the cavities, and other necessary information will not be available.

I have for years advocated some form of collapse therapy in almost all patients with pulmonary tuberculosis as soon as active disease is discovered unless, of course, there are contraindications to its use. There can be only two exceptions to this rule, the one being those patients who have such early, minimal lesions that are improving or that may be expected to improve under bed rest alone; the other is that group in which the disease is so far advanced and extensive that the procedures may appear to be futile.

Today, almost everyone who has kept abreast of the startling advances made in the surgical treatment of pulmonary tuberculosis agrees that collapse therapy should be resorted to, when possible, in all those patients in whom, after a variable length of time, it appears that the disease will not be controlled by the negative form of treatment consisting of bed rest, hygienic, and dietetic measures alone. There is still, however, much disagreement as to the advisability of instituting active surgical treatment in early, minimal lesions as soon as they are discovered. It is with this question that my paper will deal.

In this group of patients, we have three problems to consider: (1) Will the individual, unaided by some form of collapse therapy, be certain of complete and permanent healing? (2) Will the addition of collapse therapy make healing more certain, and accomplish it in a shorter period of time? (3) Will the addition of this treatment be detrimental to the patient now or in the future?

The answer to the first two questions should be obvious. No patient is certain of overcoming pulmonary tuberculosis regardless of the extent of the disease or the method of treatment. In almost all cases, if the patient does become well, it will be principally because of the rest afforded the lesion. The wonder is that anyone ever recovers from this disease unaided by some form of surgical treatment. The constant, interminable motions of respiration certainly do not tend to afford rest sufficient to allow healing. There is, moreover, no natural tendency for cavities to heal. The lung is normally under tension, and is stretched to fill the thoracic cage. Each inspiration tends to stretch it still farther which action pulls the cavity walls farther apart, and retards healing.

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

The application of any form of collapse therapy is made in the attempt to overcome these untoward actions by reducing the size of the thoracic cage, or the space in which the lung moves, in order to allow sufficient relaxation of the stretched lung to cause approximation of cavity walls, and enough restriction of motion to allow healing. The various procedures accomplish this to varying degrees, and do so, of course, regardless of the extent of the lesion, and must, therefore, facilitate healing in a shorter time in minimal as well as in advanced lesions.

We know that as long as cavities remain open, and sputum continues to be positive for tubercle bacilli, the patient is a menace to himself and all others with whom he comes in contact. These conditions, therefore, should both be eliminated as rapidly as possible.

What, then, is the excuse for withholding this form of treatment? In this group, the only argument advanced is that some patients became well before it was used—surely a slender thread upon which to cling. That some few did survive can be of but little interest to the thousands of relatives of those who did not recover, and to those who contracted the disease themselves because of needless and protracted exposure to the survivors.

Of what value are the tireless efforts of health authorities and others to induce patients to be examined frequently in order that their disease may be detected early if we fail to employ all the measures at our command to overcome this disease, when it is found, in the shortest possible time? This element of time is of serious importance both to the individual and to the community. In our present economic condition, neither the patient nor local and state agencies are financially able or willing to pay for expensive hospitalization longer than is necessary. Moreover, it is our duty always to get patients well as quickly as possible in order that they may return to the community and their families and again become self-supporting.

It is impossible to judge accurately the fate of patients with early, minimal lesions under the old regimen of treatment. During the early years of sanatorium care, before the use of the roentgen ray, no accurate diagnosis as to the extent of the lesions could be made, and it is probable that few patients in this class applied for treatment. The results of treatment also were verified by stethoscopic examination which makes this information of little value. A careful search of the literature fails to reveal any figures of real significance.

Probably one of the most interesting surveys on the results of bed rest treatment alone is that made recently by Dr. Ray Morgan of Westfield State Sanatorium in Massachusetts. He has made a careful check of all the children under the age of twenty-one who have undergone treatment at that institution. Of 200 patients treated between the years 1910 and 1920, 77 died under treatment, 123 were discharged and, of this number, 78 are now dead, making the total number of deaths 155. In another group of 198 patients treated between the years 1920 to 1927, 62 have died. In this group, there were 49 patients with cavitation, and of this number, 45 have died, and 4 are living, one of whom is in fair condition.

Zacks of Boston reports a group of 110 children whose lesions were discovered through routine school examination. After four and one-half years of treatment, 25 per cent were dead, 50 per cent were progressive, and the remainder were stationary or missing.

Barnes of Wallum Lake has published a survey of over 1,400 patients who have been treated at his sanatorium for cavitation and sputum positive for tubercle bacilli. Of his patients 95.4 per cent were dead within five years. None of the patients referred to in these surveys received the assistance of collapse therapy. Surely this is not a very heartening report for those who still refrain from the early employment of surgical treatment.

In contrast to these figures, we may cite the survey made recently at the William H. Maybury Sanatorium at Northville, Michigan. In the year 1927 when collapse therapy was first begun at that institution, their mortality rate was 25.8 per cent. During the year 1931, under the influence of early case findings and collapse therapy, the mortality rate had decreased to 10 per cent. At the same institution, those discharged as apparently arrested in 1927 were only 8.1 per cent while in 1931, the number so discharged had reached the startling figure of 34.1 per cent. It must also be remembered that in their figures of the last few years, there necessarily were included many of the old, chronic invalids who had been carried over, and also many patients who could have been discharged as arrested, but who were kept at the institution because of economic conditions since they had neither homes nor work to which to go.

In the year 1930 at the same institution, a comparison was attempted between patients treated with bed rest alone and those who received the assistance of phrenicectomy. In the cases compared, the extent and character of the disease were as nearly alike as was possible to determine. It was found that in those patients who received bed rest alone, cavities closed in 14 per cent, and decreased in size in 25 per cent of cases. Cavities increased in size, however, under this form of treatment, in 61 per cent, and cavities which had closed reopened in 42 per cent. In none of these patients did the sputum become negative. In that group in which only the assistance allowed by phrenicectomy was given, the cavities closed in 49 per cent, and decreased in size in 35 per cent. Cavities increased in size in only 7 per cent, while none of the cavities which had closed reopened. In 45.8 per cent of these patients, the sputum which had previously been positive for tubercle bacilli became negative in 45.8 per cent.

In 1930, I published a paper on the results of phrenicectomy in 500 patients, and

reported that 52.2 per cent of those patients who had sputum positive for tubercle bacilli before operation became negative following it. In this series, those patients with minimal disease and only moth-eaten cavities obtained this result in 90 per cent. Phrenicectomy is the simplest form of collapse therapy, and also is the least effective, but such figures show the efficacy of even this small amount of assistance to nature's attempt at healing. The results following the use of artificial pneumothorax therapy, which gives the greatest amount of assistance to these patients, is, of course, still more startling.

With those who argue that it is better to get well without these procedures, if possible, one could not disagree were it not for the insurmountable fact that, with our present knowledge of this disease, we are unable to determine whether or not the patient can overcome it without this assistance. If we make the experiment, many patients who cannot will certainly be lost in the hope that some few may be able to do so. Also the majority of those in whom the disease becomes arrested without this aid, require it anyway to maintain the healing.

It is sometimes said that as long as a patient is under treatment at an institution the lesion can be watched, and if it is not healing favorably, these procedures may then be applied. In theory, this attitude might seem sound, but practically, it is not. The frequent check-ups are often overlooked, or for financial reasons, it is difficult to have roentgenograms taken as frequently as necessary. In the meantime, the patient's lesion may become very much more extensive before it is re-examined. I have seen minimal, soft lesions spread and break down into cavities 4 or 5 cm. in size in a few weeks. Those who advocate watchful waiting also fail to take into consideration that many of these patients leave the sanatorium early, and because proper protection has not been given to their lesions, they rapidly become worse under careless living. The fact should also be remembered

that almost all of that large group of patients who present themselves for treatment in the far advanced and hopeless stage have passed, at some time or other, through the stage when their disease was minimal, and could have been controlled by simple measures.

So while it might be possible in some small sanatoria under ideal conditions, to make such frequent examinations with the roentgen ray that very early lesions could be watched safely for a short time without collapse therapy, such instances would be few, and the principle is a dangerous one. The vast majority of patients are cared for in homes and in large public institutions where such careful, frequent examinations cannot be made, and these principles might prove disastrous to many patients who might otherwise be saved.

Many physicians are still waiting for more statistics on the percentage of patients whose disease has become arrested after the use of phrenicectomy or other procedures before instituting them themselves. These additional figures may be of some value, but they are entirely unnecessary. We know now, without any need of further statistics, that a phrenicectomy accomplishes a certain, definite end. It will cause a minimal amount of reduction in lung volume, assist cavities in closing, and add to the necessary rest. If this amount of assistance seems sufficient to cause healing in a given lesion, then it is the procedure indicated, and the lesion must be benefited by it to that extent. If the lesion is more extensive, and requires a greater amount of collapse and rest, artificial pneumothorax is indicated, and again the lesion must be benefited proportionately to the assistance.

It is not to be expected that all patients can overcome the disease regardless of the method used, but the results of these procedures will be almost in direct proportion to the intelligence with which they are applied. In the group of patients with minimal lesions, we may expect recovery, with the proper use of collapse therapy, in almost 100 per cent. With phrenicectomy

alone, we reported, as stated above, that we obtained this result in moth-eaten cavities in 90 per cent.

We wish always to assist the patient to become well with the least sacrifice possible, and therefore apply the procedure that seems the least burdensome, and at the same time sufficiently effective. We know that the ceaseless motion of respiration retards and prevents healing, and this must be overcome in varying degrees, according to the extent of the lesion. One should start with the procedure that seems most applicable to the lesion. If this does not, in a very short time, appear to be sufficient, more drastic measures should be added. Cavities must be closed as soon as is possible with safety, and all statistics will vary according to the proper recognition of this rule. If one waits until the disease has advanced beyond the help of a phrenicectomy, the results of this operation in his hands will be negligible. This is, of course, true of all procedures.

It would be better to treat all patients with artificial pneumothorax if it were not for the fact that phrenicectomy is a simpler procedure, and accomplishes the desired result in many patients. If, in any patient, the desired result is not obtained promptly, pneumothorax should immediately be started. If this is done, the patient will have lost no time while the attempt has been made to control his lesion by the simpler measures.

The use of collapse therapy has not been found, except in occasional instances, to be detrimental to the patient either at the time of its use or in after years. In the group of patients with early, minimal disease, with or without cavitation, it is not necessary in some cases to institute a permanent collapse. Crushing of the phrenic nerve causing temporary paralysis of the diaphragm will be sufficient, in some cases, to allow healing. The patient will receive the benefit of the added rest and approximation of the cavity walls for a period varying from a few months to a year, at which time the nerve will regenerate, and the

diaphragm will resume its function. Nothing will have been sacrificed. In 1930, Dr. Wells of Saranac Lake and myself reported simultaneously on a large group of these patients on whom this operation had been performed. We both reported that, in our experience, 90 per cent of these patients had to be re-operated upon when the diaphragm resumed its function, and the nerve removed in order to allow sufficient time for healing or to maintain it. One can somewhat clearly surmise, therefore, what percentage of patients with this amount of disease will become well, and remain so, with bed rest alone.

•• In those patients with more disease than this, a permanent paralysis of the diaphragm, with or without the use of pneumothorax, is both necessary and desirable, for not only will it be an essential adjunct in the process of healing, but it will remain as a safeguard against reactivation later when the patient resumes his position in society. The slight loss of function following this procedure is rarely noticed by the patient, and the fear of it is entirely unwarranted. If this permanent protection were not given, the future life of the patient would have to be restricted in such a way as to incapacitate him for active life much more seriously than following its use.

This attempt to save unnecessary function proves disastrous in all forms of tuberculous infection. A tuberculous knee must be immobilized permanently with loss of function, as must other joints and the spine if we wish permanent healing. It must be accepted that persons with pulmonary tuberculosis, especially with cavitation, must also maintain some restriction of motion in the diseased part.

Some question the advisability of doing a permanent phrenicectomy because later in life the patient might experience some difficulty from it or might need the same procedure on the opposite side. One might, on the same grounds, question the advisability of removing a tuberculous kidney because it might be found later that the other kidney was diseased. Tuberculous

disease must be treated as it is found. In bilateral disease, however, frequent use is made of temporary phrenicectomy until it is ascertained upon which side a permanent phrenicectomy may be most urgent.

Frequent crushings to replace removal have been suggested but, in my opinion, while this is a desirable procedure in some cases, it is not a sound method to be employed when we are dealing with unilateral disease that needs constant and permanent rest. There is always a variable period of time after a crushing in which the diaphragm regains some motion, frequently sufficient to prevent proper rest. This incomplete rest is sometimes enough to allow cavities to reopen, with possible spreads to the other lung before it is detected, and the nerve is again crushed. Because of scar tissue, subsequent crushings become more and more difficult and dangerous. Moreover, any lesion that requires the use of frequent crushings is sufficiently dangerous to warrant an immediate and permanent phrenicectomy to insure permanent healing.

If disease does occur in the contralateral lung later, we may still institute artificial pneumothorax on that side, or if this is impossible because of adhesions, a phrenic crushing may be done. I have performed a considerable number of bilateral phrenicectomies, and have seen no untoward results in any of the patients. However, a phrenic crushing should always be performed in bilateral disease before the nerve is removed in order to determine the effect upon respiration, and because it may be necessary or advisable to do an upper stage thoracoplasty on one or both sides later, and a functioning diaphragm may be desirable.

As a general rule, therefore, it seems to me unsound to refrain from properly caring for a lesion already present because of the possibility of some future happening. The dangers attendant upon this procedure have not, in my hands, been worthy of mention. In over 3,000 patients on whom I have performed this operation, I have

had no operative mortality nor any serious accident. Occasional mishaps such as cutting the wrong nerve, severing the carotid, the jugular, the thoracic duct, etc., have been reported by others, but in experienced hands, these accidents occur very rarely.

There are also, following the use of artificial pneumothorax, occasional and rare accidents such as air embolism, spontaneous collapse of the lung, empyema, and some few unfavorable reactions to novocaine, but these accidents occur so seldom that they cannot be given serious consideration.

Much is said of the danger of diaphragmatic hernia in later years following the use of phrenicectomy. Still, after over twenty years of experience with this procedure both in this country and in Europe, there is only one such case in the literature. I have encountered none. The paralyzed diaphragm, while losing its muscle tone, becomes a very tense, firm membrane, stronger if anything than it was before. I have seen many of these, years after phrenicectomy, and it was difficult to see how hernia could take place.

It seems incongruous to dwell on the possible dangers of these procedures when withholding them will cause such a tremendous toll of lives, and an inexcusable financial burden to the people. Our aim must be to diagnose and treat actively all patients with this disease as soon as possible.

Even in the more advanced and chronic patients, when phrenicectomy and artificial pneumothorax have been ineffectual, excellent results may be obtained from thoracoplasty. This is especially true since the technique of this operation has been improved. The removal of the entire length of the upper ribs to, and occasionally including, the costal cartilages, has entirely changed our conception of the results which may be obtained following this procedure.

Equally as important as treatment, however, is the necessity of proper early diagnosis and case findings, for thousands of people who are in need of treatment are living today in a false sense of security because of reassurance given to them after an inadequate or untrustworthy stethoscopic examination, while many thousands, too, have been sacrificed because of this method of examination. When that time arrives when physicians send their patients to the roentgenologist for assistance in the early detection of the disease instead of depending upon the stethoscope, we shall be on the right approach to the proper treatment of pulmonary tuberculosis. And when those patients who have benefited by this early diagnosis are hospitalized and given the assistance of collapse therapy early in the course of their disease, we shall see the beginning of the end of pulmonary tuberculosis as a serious menace to society.



THE TUBERCULOSIS PROBLEM IN DETROIT*

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DETROIT, MICHIGAN

TUBERCULOSIS is classed as a communicable disease and therefore becomes a responsibility of the Department of Health as is the case with acute infectious diseases. The control of tuberculosis by this department, therefore, involves diagnosis, treatment and the segregation of open cases to prevent spread of infection.

The disease is of such long duration that most persons with tuberculosis soon exhaust their savings, their earning power lessens or ceases altogether, and they have to be maintained by public funds. Then again the modern treatment requires hospital and sanatorium facilities, and for this reason a period of institutional care is advisable for all patients. In the sanatorium a patient learns the fundamentals upon which cure depends and the methods necessary to prevent infecting others. These essentials cannot be satisfactorily taught and put into effect in the average home.

Detroit has a unified tuberculosis program, all of which is administered by the Department of Health. This includes diagnostic clinics, case finding in schools, hospitalization of patients, the supervision of indigent patients in their homes, and medical supervision of the tuberculous children in the open air and open window schools.

DIAGNOSTIC CLINICS

A central diagnostic clinic is maintained for indigent persons at the Herman Kiefer Hospital. This is open each week day, and one or more diagnosticians are in attendance. All children are tuberculin tested, and the reactors have a roentgenogram of the chest. Single films are taken as a routine of all adults coming to the clinic and stereoscopic films in special cases.

VALUE OF THE ROENTGENOGRAM

There have been four outstanding discoveries recorded in medical history that have greatly increased our knowledge of tuberculosis. The first of these was the treatise published by Auenbrugger in 1761 in which he demonstrated a method of percussion by which the comparative densities of subjacent parts can be determined. The second was the publication of the book by Laennec in 1819 on "The Diagnostic Value of Mediate Auscultation by Use of a Stethoscope." The third was the discovery of the tubercle bacillus by Koch in 1882, and the fourth was the discovery of the x-ray by Roentgen in 1895. One hundred and thirty-four years elapsed between the first and the last of these important epochal discoveries; and even up to the present time the period since Auenbrugger could be covered by the life span of two individuals.

In relation to world history the knowledge upon which the diagnosis of pulmonary disease rests is a very recent possession. Each of the scientists mentioned thrust forward the then existing knowledge upon which the diagnosis of pulmonary tuberculosis was based. Koch and Roentgen, however, have given us methods of greater precision which have since been elaborated in the clinic and x-ray laboratory until the diagnosis of pulmonary tuberculosis may be made with greater accuracy than is possible by physical examination.

For the diagnosis of pulmonary tuberculosis we place but little dependence on auscultation and percussion in our clinics. It is a conservative statement to say that 20 per cent of error will be made by physicians, even those specializing in tuberculosis, who depend upon a physical examination to diagnose pulmonary tuberculosis. At least 60 per cent of minimal cases and

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some of the advanced cases, especially those with bilateral fibroid disease, will be missed. Not only will cases of pulmonary tuberculosis be missed, but many others will be erroneously diagnosed as having that disease. This leads to serious consequences. The undiscovered cases lose valuable time in securing proper treatment and the non-tuberculous cases are caused much unnecessary inconvenience, expense and worry. Furthermore, the really incipient form of tuberculosis, the childhood type, cannot be diagnosed by physical examination even by the most skilled physicians. Only by the roentgen examination can it be demonstrated. The relative value of the two methods as showing the extent of disease is illustrated in the following tables.

Note the change in classification of those before 1929 and after that date. In 1927 and 1928 the diagnosis and classification were made largely by physical examination. About the middle of 1929 a change in procedure was made, and all patients thereafter were classified according to the roentgen findings. The shift from minimal to the

per cent of these persons were found to have some form of tuberculosis.

About one-third of the new patients were referred by physicians for diagnosis, largely because the patient could not afford to pay a roentgenologist's fee. In these cases a report is sent to the physicians giving the diagnosis as shown by the roentgenogram and sputum examination. A physical examination is made, but more for the purpose of finding other pathological conditions than for its value in demonstrating tuberculosis. Another third of the patients came in for examination because of illness or symptoms which led them to suspect tuberculosis, and the balance were persons who came to the clinic for a check-up because of exposure. The field nurses try to get all contact children into the clinic for examination. Eighty-five per cent of the children living in a home in which a case of tuberculosis was found were given a tuberculin test and roentgen examination. Of these, 18.5 per cent were found tuberculous; 1,927 other children without history of exposure were examined, and but 10.5 per cent were diagnosed as tuberculous.

CLASSIFICATION OF DIAGNOSED CASES

Classified by Physical Examination

Year	Minimal per cent	Moderately Advanced per cent	Advanced per cent	Total No.
1927	36.2	52.5	11.2	1711
1928	41.0	46.8	12.1	1932
1929	32.0	51.7	16.3	2323

Classified by Roentgenogram

1930	15.2	29.3	55.2	1927
1931	20.8	30.3	48.9	1951
1932	17.8	34.4	47.8	1627

far advanced group is very striking as a study of the table will show. The reason for this is that the roentgenogram reveals a greater area of disease and the presence of cavities that cannot be demonstrated by physical examination.

CLINIC ATTENDANCE

This has increased from 21,000 in 1928 to 44,000 in 1932. The number of new pa-

FIELD NURSING

The city is divided into nursing districts. There are five in which generalized nursing is done and eighteen others in which there is specialized nursing, the nurse giving her whole attention to the tuberculosis cases in her area. Each nurse is expected to follow up the cases diagnosed in the clinic, the patients discharged from sanatoria and all reported cases of tuberculosis who are

not under the direct supervision of a private physician. She gives instruction as to proper sleeping quarters, the value of fresh air, teaches concurrent disinfection and care of sputum, personal hygiene, proper diet, instructs the patient how to control cough and to cover the mouth when coughing, encourages the patient to continue treatment until results are obtained. She endeavors to get all contacts, adult and children, into the clinic for examination. In cases under the care of a private physician similar instructions are given with the physician's consent.

CASE FINDING AMONG SCHOOL CHILDREN

•• In many places in the United States school children are being tuberculin tested and the reactors roentgenographed to find the cases of tuberculosis before symptoms develop. The tuberculin test is used as a screen to determine infection, and a roentgen examination of these positive reactors will reveal the children who have developed pulmonary and tracheobronchial lymph node tuberculosis.

The Tuberculosis and Health Society of Wayne County cooperates with the Department of Health in holding clinics in the schools. During 1929, 1930 and 1931, 16,042 school children were tuberculin tested. These represented 67 per cent of the enrollment in these schools. Thirty-two per cent of the high school pupils and 19 per cent of the grade pupils showed a positive tuberculin reaction. There were 3,499 roentgenograms taken of the reactors. In the high schools 0.4 per cent of the students and three in 11,216 grade school pupils were found to have the adult type of tuberculosis. This is usually a fatal form of disease in children unless detected early and adequate and prompt treatment given. These cases are often spreaders of tuberculosis, and they should be excluded promptly from school. For this reason alone the finding of even one justifies the effort and expense of such surveys. In addition, however, there was 4.6 per cent with the childhood type of tuberculosis in the high schools and 3.5 per

cent in the grade schools. These children will usually overcome their disease if their condition is known and they are given proper care and supervision. It is very important that they be separated from the source of infection. Frequently the finding of a tuberculous child in the school will, if followed up, lead to the diagnosis of tuberculosis in other members of the family.

OPEN AIR SCHOOLS AND OPEN WINDOW ROOMS

In the public school system there are twelve open air schools and fifty-two open window rooms in school buildings. There are also open air schools at the Maybury Sanatorium and at the Detroit Tuberculosis Sanatorium. In the public school system 3,809 pupils were enrolled in these special schools last year. The children are assigned through the tuberculosis clinic, and the basis of selection is a positive tuberculin test with roentgen evidence of childhood type tuberculosis or a positive tuberculin test associated with malnutrition or poor general condition. These children are under the supervision of one of the clinic physicians throughout the school year, and roentgenograms are taken every six months.

HOSPITAL AND SANATORIUM CARE

• The city owns two large institutions with a capacity of 1,500 beds used exclusively for the treatment of tuberculosis patients. These are operated by the Department of Health. The Herman Kiefer Hospital with 670 beds is used as a receiving hospital for all forms of tuberculosis. The William H. Maybury Sanatorium with 830 beds is situated at Northville, twenty-five miles from Detroit. After a period of observation at the Hospital the most favorable cases are transferred to the Sanatorium. Patients who cannot be accommodated in these two institutions are assigned to seventeen other hospitals and sanatoria. Three of them are general hospitals which only recently, because of the large number of vacant beds, have been willing to accept tuberculosis cases. Because of these added facilities

2,236 tuberculosis patients are being given hospital care. This represents about one-third of the registered tuberculosis cases in the city.

There is no waiting list, and patients can be hospitalized promptly as applications are made. This gratifying situation was not possible until there were two available beds for each death. This appears to be the proper ratio necessary to care for all cases of tuberculosis where adequate clinic diagnostic service is maintained.

Wayne County pays the maintenance costs of all the indigent patients hospitalized in these city and private institutions. The County is reimbursed one dollar per day per patient by a subsidy from the State.

TUBERCULOSIS IN THE NEGRO

There are about 120,000 negroes in Detroit, comprising 8 per cent of the city's population. They contribute 32 per cent of the total deaths from tuberculosis. The rate per 100,000 for 1932 for the whites was 50.3, for the colored 312.

Efforts have been successful in arousing the interest of the colored physicians in this serious problem of their race, and they have become active in diagnosis and treatment. Four small hospitals with a total capacity of 200 beds are now operated and staffed by colored physicians and nurses.

REGISTERED CASES OF TUBERCULOSIS

There are now 7,383 cases of tuberculosis on the register. In 1932 there were 1,052 deaths. Therefore, we have approximately seven known cases of tuberculosis for each death. Thirty per cent of the known cases are in hospitals and 70 per cent are living at home, many of whom have had a period of sanatorium treatment. But 269, or 3.6 per cent, are under the care of private physicians. The others are under clinic supervision.

The financial status of all patients hospitalized is investigated by the County Auditor's office. They report that less than 10 per cent are able to pay even a small

part of their hospital maintenance. This shows to what a large extent tuberculosis has become a public health problem and why so few patients are financially able to employ a private physician.

TREATMENT

The treatment of pulmonary tuberculosis has been revolutionized in the past few years and to carry it out requires that the sanatorium be equipped with an operating room or have an affiliation with a general hospital. The medical staff should include a thoracic surgeon and consultants representing the various specialties. Tuberculosis is a disease of long duration, and during its course a patient may develop any one of the other ills that affect mankind. A good roentgenological department is indispensable. After the diagnosis is made frequent roentgenograms are essential in recording changes occurring in the course of the disease. The roentgenogram records the location and extent of the lesion and gives information as to the character of the infiltrations or consolidations, the size and location of cavities, the presence of fluid, displacement of trachea and mediastinum, and size, outline and location of the heart—all factors that are necessary to know before deciding upon the form of treatment best suited to the patient.

Artificial pneumothorax treatments could not be carried out without the use of the roentgenoscope to observe the amount of collapse and the effect on the diseased area. At the Herman Kiefer Hospital and Maybury Sanatorium over 2,000 pneumothorax treatments are given each month, and a roentgenoscopic examination is made of each patient before and after each treatment.

The therapeutic use of the roentgen ray in sanatoria is practically limited to the treatment of tuberculous cervical lymph nodes. In such cases it is found of great value.

RESULTS OF TREATMENT

The results of treatment at the Herman Kiefer Hospital and William H. Maybury

Sanatorium should be considered together, as otherwise they would be misleading. The policy adopted in 1929 to use the Herman Kiefer Hospital as a receiving hospital and transfer the favorable cases to the Maybury Sanatorium has been continued. The cases at the Sanatorium needing bronchoscopic examination, a thoracoplasty or ma-

persuade a patient in the minimal stage without notable symptoms to accept sanatorium treatment than one who is really ill. Education of doctors and the laity that early active treatment is as essential to cure as is early diagnosis will bring about an improvement in this condition.

The following table shows some encour-

CLASSIFICATION OF PATIENTS ADMITTED TO HERMAN KIEFER HOSPITAL

Year	Minimal Per cent	Moderately Advanced Per cent	Far Advanced Per cent	Deaths Per cent
1929	10.1	14.4	75.5	35.0
1930	10.0	14.5	75.5	31.2
1931	13.3	25.1	61.6	21.6
1932	15.4	28.6	56.0	20.3

jor surgery of any kind are transferred to the Herman Kiefer Hospital for operation. Therefore, many cases begin treatment at one institution and finish in the other. For that reason few patients are discharged from the Herman Kiefer Hospital with the disease arrested or quiescent, the favorable cases having been sent to Maybury Sanatorium to finish the cure.

Last year, of the patients admitted to Herman Kiefer Hospital, 800 were favorable for treatment and 453 were so far advanced at the time of admission that treatment offered little hope for recovery. It is this unfavorable group that accounts for the large number of deaths at the Herman Kiefer Hospital. It is more difficult to

aging results from the efforts made to get patients under treatment early. There is a decided shift in percentage of far advanced cases toward the moderately advanced and minimal stage groups.

Collapse therapy is being used to a greater extent each year, with correspondingly greater improvement in the patients under treatment. The decrease in deaths in four years at the Herman Kiefer Hospital from 35 per cent to 20.3 per cent and at the Maybury Sanatorium from 18 per cent to 6.5 per cent is further proof that the treatment given is much more effective.

The following table will indicate the improvement in the results of treatment that has taken place at the Maybury Sanato-

COMPARISON OF PERCENTAGES OF RESULTS DURING PAST SIX YEARS OF DISCHARGED ADULTS

	1927 Per cent	1928 Per cent	1929 Per cent	1930 Per cent	1931 Per cent	1932 Per cent
Apparently arrested.....	8.1	14.0	18.5	27.4	34.1	35.4
Quiescent.....	17.8	7.2	9.8	21.8	19.4	16.8
Improved.....	19.5	21.2	17.1	17.7	15.4	17.6
Total Favorable Results.....	45.4	42.4	45.4	66.9	68.9	69.8
Unimproved.....	21.2	23.6	22.4	14.4	13.3	18.6
Stay too short to note change.....	7.6	4.4	9.5	8.4	6.3	4.8
Died.....	25.8	25.2	18.1	10.0	10.0	6.5
Non-tuberculous.....	0.0	4.4	4.6	0.3	1.4	0.2

rium in the last six years. In 1927 only 8.1 per cent of the patients were discharged as apparently arrested whereas in 1932 it had risen to 35.4, and the total favorable results had increased from 45.4 per cent in 1927 to 69.8 per cent in 1932.

A recent survey of the patients under supervision of the Detroit Department of Health showed that of the 2,218 adults with pulmonary tuberculosis receiving hospital or sanatorium care 75.7 per cent had had pneumothorax, phrenic nerve surgery or thoracoplasty, or a combination of these methods of treatment as shown in the following table.

was 93.9, in 1930, 82.7, in 1931, 73.8, and in 1932, 70.3, a drop of 26 per cent in the last five years.

TUBERCULOUS MENINGITIS

There was also a significant decrease in deaths from tuberculous meningitis as compared with the preceding years. From an average number of 122 deaths per year for 1928, 1929 and 1930 the number dropped to 72 in 1931 and 74 in 1932, or a decrease of 40 per cent. As there has been found no specific treatment for this disease, and only a rare case is known to recover, we must assign the reason for this lessening in-

COLLAPSE THERAPY PROCEDURES THAT HAVE BEEN EMPLOYED IN THE TREATMENT OF PATIENTS WITH PULMONARY TUBERCULOSIS IN THE INSTITUTIONS AS OF JANUARY, 1933

Procedure Employed	Minimal	Moderately Advanced	Far Advanced	Total
Pneumothorax unilateral, alone	13	156	342	511-23.0%
Pneumothorax bilateral, alone	0	11	100	111- 5.0%
Pneumothorax and phrenicectomy, same side . . .	8	87	194	289-13.0%
Pneumothorax and phrenic surgery on opposite sides	0	15	61	76- 3.4%
Pneumothorax bilateral with phrenic surgery . .	0	0	12	12- 0.6%
Pneumothorax with phrenicectomy and intrapleural pneumolysis	0	0	1	11- 0.04%
Pneumothorax and intrapleural pneumolysis . .	0	8	6	14- 0.6%
Phrenicotomy (crushing of phrenic nerve) alone .	11	16	18	45- 2.0%
Phrenicectomy (evulsion or complete dissection of nerve) alone	81	204	182	467-21.1%
Bilateral phrenic nerve surgery	0	1	9	10- 0.4%
Bilateral phrenicectomy with unilateral pneumothorax	0	0	1	1- 0.04%
Thoracoplasty	0	8	123	131- 6.0%
Extrapleural pneumolysis (paraffin filling, muscle transplants, etc.)	1	0	4	5- 0.2%
Other surgery on chest—scaleneotomy, first rib removal, etc.	0	0	6	6- 0.27%
Number receiving no form of collapse therapy . .	92	118	329	539-24.3%
Total, without duplicates	206	624	1388	2218

1,679 collapse therapy cases out of 2,218 adults, or 75.7 per cent.

REDUCTION OF DEATH RATE

There was but little change in the death rate from tuberculosis in Detroit during the ten years preceding 1929. Since then the number of deaths has shown a steady decrease each year. For 1928 the rate for all forms of tuberculosis was 95.1. In 1929 it

cidence of tuberculous meningitis to fewer opportunities for children to become infected through exposure to open cases of pulmonary tuberculosis in the home.

Many factors have contributed to bring about the substantial decline in the tuberculosis rate. Among them are adequate hos-

pitalization facilities, which has brought about segregation of many spreaders of infection and gives opportunity for more effective treatment. Early diagnosis is made possible by the general use of the roentgenogram. The method of tuberculin testing contacts and school children and a roentgen examination of the reactors finds cases of tuberculosis before symptoms ap-

pear and when the patient is in a condition to respond favorably to treatment. Finally, the use of the pneumothorax or of some form of thoracic surgery in all cases where collapse therapy is applicable to supplement the bed rest which all patients receive. All these procedures have a part in carrying on a successful campaign against the tubercle bacillus.



CALCIFICATION IN AORTIC AND MITRAL VALVES

WITH A REPORT OF TWENTY-THREE CASES DEMONSTRATED IN VIVO BY THE ROENTGEN RAY*

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INTRODUCTION

CALCIFICATION in chronically diseased valves of the heart is a frequent finding at the post-mortem table. For many years the pathologist and the cardiologist have been asking the roentgenologist why he could not show these calcified areas by roentgen examination of the living patient. Our defense has been that the equipment has not been powerful enough or fast enough to do so. It is a sad commentary on the ability of the thousands of men, who do roentgenoscopy almost daily, to learn that we have had the proper equipment for years, certainly for thirty of the thirty-eight years since Roentgen's discovery. As is so often the case, one sees only what one looks for, and if anyone had thought to actually look for these calcified valves in a series of cardiac patients, he certainly would have seen them, as they are easily visible with the ordinary roentgenoscope and are a very common finding in patients with chronic valvular heart disease. The recording of these shadows on films is a different matter, and it is only recently that we have had the equipment powerful enough and fast enough to make the short exposures necessary to delineate them.

Our first case of calcified heart valve visible by roentgenoscopy in vivo was recorded ten years ago,⁸ but in a rather uncertain manner, as it could not be demonstrated on films at that time. Only occasionally since then had a similar finding been recorded until Christian⁴ began his studies on "Aortic Stenosis with Calcification." From a study of post-mortem cases he was able to develop criteria

whereby he could state that aortic stenosis with a considerable degree of calcification was present in a given case. He sent such cases to us with the specific request to demonstrate the calcification, if possible, and we were able to do so in nearly all of the cases. One of his early cases was published,⁵ it being the first case of aortic stenosis with calcification recognized in vivo to appear in the literature. Having developed a satisfactory method of roentgenoscopic and roentgenographic examination, we independently found other cases of calcified aortic valves and an equal number of calcified mitral valves. We are reporting here our first 25 cases of calcified valves, 23 of which were demonstrated by roentgen examination in the living subject, and in the other 2 after death. One of these 2 was missed at roentgenoscopy although the diagnosis was made clinically, and the other patient was not examined by us until after death, the films confirming the clinical diagnosis. In 4 of the patients who have come to autopsy, 3 had calcified aortic valves and one had calcification in the mitral valve.

HISTORICAL

The first recorded case of intracardiac calcification, demonstrated by roentgen examination ante mortem, was published in 1903 by Rudis-Jicinsky.¹⁹ The illustration accompanying his article is so poor and the technical difficulties of those times were so great, that it is hard to believe he actually demonstrated calcification in the heart valves. The report itself is vague and unsatisfactory, and it is not stated that diagnosis was made ante mortem. This probably

* From the Department of Roentgenology and the Medical Clinic of the Peter Bent Brigham Hospital, Boston, Mass. Read in abstract at the 20th Reunion of the Hospital Staff, May 4-6, 1932.

represents a case of *ex post facto* diagnosis.

In 1908 Simmonds²¹ published a fundamental work on intracardiac calcification as shown by roentgen examination of hearts removed at autopsy. He divided the lesions by their location into four main groups: pericardial, endocardial, myocardial and arterial (coronary). No record was made of attempts to demonstrate these areas in the living subject.

Pericardial calcification was the first entity to be reported as demonstrated *in vivo*, and in 1922 Klason¹³ summed these up, added 4 cases of his own and reported one case of intracardiac calcification, probably the first authentic case of calcified valves demonstrated in a living patient. He found ring-shaped shadows of calcification in the region between the auricle and ventricle, noted their movement from right to left with systole and concluded that they were located in the annulus fibrosus of the mitral valve.

In 1924 one of us with Cutler⁸ reported 5 cases of calcification in the heart. In 4 of these the calcification was chiefly pericardial, but one of them (Case 1) at autopsy showed marked calcification in the aortic, mitral and tricuspid valves.

These were not recognized *ante mortem*. However, Case v, reported briefly and not confirmed by autopsy, was recognized as showing calcification in the mitral valve. This patient cannot now be traced, and the final proof is lacking.

In 1925 Fleischner¹⁰ reported a case of calcification in the annulus fibrosus with the *ante-mortem* diagnosis confirmed at autopsy. Post-mortem films also revealed calcification in the coronary arteries and in the ductus arteriosus.

In 1932 Saul²⁰ published a short but excellent report of 3 cases of intracardiac calcification, with observations and conclusions quite similar to ours independently being made at the same time. He described the roentgenoscopic findings in detail and concluded, as we have done, that this is the best method for demonstrating the calcified valves. All three of his patients had calcification in the mitral annulus fibrosus; one of them was confirmed by autopsy. Saul was unaware of the American literature on this subject.

Shortly after Saul's report, Parade and Kuhlmann¹⁸ published 4 cases of intracardiac calcification, 3 in the mitral valve and one in the aortic valve.

TABLE I
AORTIC VALVE CALCIFICATION

Number	1	2	3	4	5	6	7	8	9	10	11	12
Age	53	56	56	59	60	63	68	69	70	70	72	72
Sex	m	m	m	m	f	m	f	m	m	f	m	m
History of rheumatic fever	+	±	+	±	o	o	o	+	o	+	o	o
Years between rheumatism and discovery of calcification	51	50 (?)	42	50 (?)	o	o	o	60	o	23	o	o
Signs of cardiac insufficiency	+++	++++	+	++	o	o	±	o	+	o	±	o
Duration of cardiac symptoms in years	5	4	2/12	6 1/2/12	o	3-4	2	o	5	o	2	2/12
Duration of known heart disease in years	1/12	1 1/2/12	34	o	o	6/12	o	11	5	23	o	o
Basal thrill	+	o	+	+	+	+	o	+	+	+	+	+
Basal systolic murmur	+	o	+	+	+	+	+	+	+	+	+	+
Basal diastolic murmur	+	o	+	o	o	+	o	+	o	o	o	o
Decreased pulse pressure	o	+	o	+	o	+	o	+	o	o	o	o
Cardiac hypertrophy	+	+	+	+	+	+	o	+	+	+	+	+
Roentgen demonstration of calcification	+	+	o	+	+	+	+	+	+	+	+	+
Blood pressure	120/65	155/120	180/95	112/100	200/110	160/110	110/68	180/80	140/54	190/90	180/96	115/50
Signs of mitral disease	o	(?)	+	o	o	o	o	o	o	o	o	o
Auricular fibrillation	o	+	+	o	o	o	o	o	o	o	o	o

Cases of aortic stenosis with calcification, arranged in the order of the patients' ages.

CLINICAL

A. Aortic Stenosis with Calcification.

In summing up our 12 cases of aortic stenosis with calcification (Table 1) it was noted that the clinical characteristics agreed closely with the criteria postulated by Christian.⁴ These were as follows:

1. *Occurrence chiefly in males relatively late in life.* There was a preponderance of males in our series, 9 males to 3 females. The average age of the group was sixty-four years. The average age for the males was sixty-one and for the females sixty-six. The youngest patient in the series was fifty-three years old and the oldest seventy-two at the time of the discovery of the calcification.*

2. *History of rheumatism early in life.* Six of our 12 cases gave a definite rheumatic history. Four of these showed a lapse of fifty years or more from that infection to the discovery of the calcified valves. In Case x, the etiology of the heart lesion was considered to be a severe infectious arthritis that occurred twenty-three years previously. Attempts were made to verify this and to determine the time of onset of the cardiac lesion through the records of earlier hospitalizations. These were unavailing. There were many reasons why a history of a preceding rheumatic fever was obtained in only one-half of the patients. This process, if it had occurred, had done so at an early age, and the details of the infection could not be remembered. One patient was unconscious; others suffered from senile changes. The history of childhood diseases was rather poor for the entire group. Then, too, we considered only rheumatic fever, chorea and severe "growing pains" as constituting a positive history.

3. *Slow progression of the lesion with symptoms of decompensation appearing late though not necessarily prolonged after de-*

velopment. The majority of our group were hospital patients, and 7 of these showed some evidence of cardiac failure by the usual signs. Cardiac symptoms were present in 9 cases, and these had been present from two months to five years. Only 4 of the patients were unaware of their heart damage and in 8 cases the duration of that knowledge varied from one month to thirteen years.

4. *Presence of a systolic thrill and harsh, loud systolic murmur in the aortic area, with or without a diastolic murmur of aortic insufficiency.* In 10 of our 12 cases there was a definite basal thrill and in 11 cases a roughened, harsh basal murmur. Both were systolic in time. A diastolic murmur was heard at the base in only 3 cases, though the presence of aortic insufficiency could be suspected from the low diastolic pressures in 3 additional cases.

5. *Often a characteristic pulse with normal or decreased pulse pressure.* The pulses of our patients were often slow and small in amplitude. A decreased pulse pressure was noted in 3 patients, 2 of whom showed fairly marked myocardial insufficiency.

6. *Enlargement of the heart.* Cardiac hypertrophy was present in 11 of the patients. This was determined clinically and checked by the roentgen examination.

7. *Roentgenographic demonstration of calcification in the region of the aortic valve.* Eleven patients were shown to have intracardiac calcification in the aortic valve area by the roentgen ray. The remaining case is included to show that very small amounts of calcium deposit may be overlooked during life.

8. *Typical autopsy findings in the aortic valve, other valves not organically abnormal, with great hypertrophy of the heart.* Our autopsy material is mentioned later.

9. *Miscellaneous findings.* The blood pressures tended to be elevated in 7 patients as evidenced by the diastolic readings. Case 11 showed questionable signs of mitral stenosis and the diagnosis of mitral disease had been made on previous hospital admissions. The calcification present was

* A twenty-eight year old male was recently examined anatomically and reported.³ He had marked calcification of the aortic valve with no change in the mitral valve and no history of rheumatism. The lesion was typically that which occurs in older individuals. One year before his death he was roentgenoscoped in the Peter Bent Brigham Hospital, Roentgen Ray Department, and no intracardiac calcification was found. This was done by a House Officer who evidently did not look for calcified valves.

in the aortic area roentgenographically, and unfortunately, though the patient died, autopsy permission was denied so that this could not be checked. Mitral disease was considered to be present in Case III, and slight stenosis and insufficiency were demonstrated pathologically. In only these two patients was there any evidence of organic disease of the mitral valve, and in these two the mitral lesion seemed but slightly developed. Cases II and III were the only ones showing auricular fibrillation. The Wassermann and Hinton reactions on the blood serum were negative in

1. *Age and sex incidence.* There were 8 males and 5 females. Their average ages were 49.5 and 52.6 years respectively. The youngest patient was twenty-four years of age and the oldest seventy-seven years.

2. *History of rheumatic fever.* A definite history of rheumatic fever was obtained in 7 of the cases and all of these were in the youngest 9. Three had had rheumatic fever more than once.

3. *Time relationships—failure.* Whenever present in the history, the rheumatic fever had occurred from eleven to thirty-six

TABLE II
MITRAL VALVE CALCIFICATION

Number	13	14	15	16	17	18	19	20	21	22	23	24	25
Age	24	33	34	38	38	42	44	52	56	58	72	76	77
Sex	f	m	m	f	m	m	m	f	m	m	f	m	f
History of rheumatic fever	o	+	+	+	+	+	+	o	+	o	o	±	±
Number of attacks of rheumatic fever	o	2	1	3	1	2	1	o	1	o	o	—	—
Years between rheumatism and discovery of calcification	o	23	16	30	11	25	22	o	36	o	o	60-70 (?)	50-70 (?)
Signs of cardiac insufficiency	o	o	+	o	++	+++	+	+	o	+++	o	o	+
Duration of cardiac symptoms in years	o	4	9	1	2	3	5 ⁶ / ₁₂	5	4	9 ¹ / ₁₂	7	2	30
Duration of known heart disease in years	10	4	16	1	11	3	5 ⁶ / ₁₂	5	3	1 ¹ / ₁₂	o	2	30
Apical thrill	o	+	+	o	o	o	+	+	o	o	o	o	o
Apical diastolic murmur	+	+	+	+	+	+	+	+	+	o	o	o	o
Apical systolic murmur	+	+	+	+	+	+	+	+	+	o	+	+	+
Blood pressure	118/50	115/75	116/44	130/90	130/75	145/100	118/70	118/78	165/80	105/60	190/74	148/70	148/70
Cardiac hypertrophy	+	+	+	+	+	+	+	+	+	+	+	+	+
Roentgen demonstration of calcification	+	+	+	+	+	+	+	+	+	+	+	+	+
Signs of aortic disease	+	+	+	o	o	o	o	o	o	+	+	+	+
Auricular fibrillation in years if known	o	+	9	o	+	+	5 ⁶ / ₁₂	4	+	+	o	o	o

Cases of mitral disease with calcification, arranged in the order of the patients' ages.

all of the cases. Ten years previously Case XII was diagnosed general paresis, but this had been completely arrested. Electrocardiograms did not show characteristic curves for the group.

B. Mitral Disease with Calcification.

There were 13 cases of calcification in the mitral valve. These are tabulated in Table II. An effort was made to establish a clinical picture that might enable us to diagnose during life the presence of calcification in mitral disease by means other than the roentgen ray, but this failed.

years previous to the discovery of the calcification. This was a shorter interval than was noted in the aortic group but was to be expected, remembering the average ages for the groups. Twelve cases had had cardiac symptoms from nine months to nine years. Twelve cases had been aware of the existence of their heart disease, and had known of it from one month to sixteen years. The youngest patient (aged twenty-four) could give no history of rheumatic fever, and, though she had been told of her heart lesion, she did not have any cardiac

symptoms. In the 4 older patients, one was entirely unaware of any heart disease though she was seventy-two years old and had had cardiac symptoms for seven years. The other 3 patients had had cardiac symptoms for two, seven, and thirty years. The usual signs of cardiac insufficiency were noted in 7 of the 13 patients.

4. *Murmurs and thrills.* An apical thrill was found in only 3 of the 9 younger cases, but in view of the fact that 7 of the patients' hearts were fibrillating this was to be expected. A diastolic and systolic murmur were heard at the apex in all 9 youngest patients. The 4 older patients did not show either apical thrills or diastolic murmurs. A systolic murmur was present in 3 of these 4 cases. This was not surprising at the ages of seventy-two, seventy-six and seventy-seven with slight increases in blood pressure, and chronic myocarditis.

5. *Blood pressure.* The blood pressures for the entire group tended to be low, increasing slightly in the oldest patients.

6. *Enlargement of the heart.* Cardiac hypertrophy was present in 12 of the 13 cases.

7. *Roentgenographic demonstration of calcification.* Calcification in the mitral valve area was seen in all of the cases.

8. *Miscellaneous findings.* Auricular fibrillation appeared in 8 of the 13 cases. It is interesting to note that the clinical signs of aortic valvular disease appeared only in the 3 youngest patients in this group (Cases XIII, XIV and XV). The Wassermann and Hinton reactions on the blood serum were negative in all of the cases. Electrocardiograms yielded no information that could be applied to the problem of calcification of the valves.

The seemingly artificial division of the mitral cases into two groups, a younger (9 cases) and an older (4 cases) group, is well borne out by a study of the 11 cases reported in the literature^{8,10,13,18,20}. The reported cases of the younger group showed definite signs of mitral stenosis whereas the older patients entered hospitals or dispensaries showing at most a systolic murmur at the apex. Fleischner's case, aged

eighty-five, Saul's case, aged eighty, and Parade and Kuhlmann's case, aged seventy-two, all showed calcification in the mitral ring on pathological examination. These patients did not show evidence of mitral stenosis or insufficiency on clinical examination.

Though we cannot offer absolute proof because of the paucity of our post-mortem material, we do feel that the younger patients who presented definite clinical evidence of mitral valve disease showed smaller amounts of calcium deposit which we think is mainly in the valve leaflets. In the older group of patients, who presented no evidence of mitral disease clinically, we feel that the heavy, ring-shaped shadows that have been described were more apt to be in the annulus fibrosus.

From the clinical findings, then, it is not possible with our present knowledge to diagnose calcification in a case of mitral stenosis. It may be suspected, however, because of its frequent occurrence. In older patients calcium deposit may be present but unsuspected. They often do not have physical signs of cardiac disease. In these cases the calcification is apt to be in the annulus fibrosus.

The question of the importance of the finding of calcification in heart valves is an interesting one. In all of these cases one may infer that the process has been present for a long time when the calcification is found, and that the causative process has long since passed. The roentgen demonstration of calcification in the aortic valve is a valuable adjunct in the diagnosis of aortic stenosis with calcification. We believe that it will be of definite help in establishing a diagnosis of chronic valvular heart disease, confirmatory usually, but in certain cases of critical value. We believe that rheumatic fever is the preceding and causative agent in many of the cases. Syphilis has not caused such calcified lesions in any of our cases. In our group of patients with calcification of the valves, subacute bacterial endocarditis has so far been absent as a complication.

ETIOLOGY AND PATHOLOGY

Calcium salts have been found deposited in all of the various structures of the heart. Saul²⁰ has summed these up as follows: (1) pericardial calcification, the highest degree of which is called "armoured heart" (Panzerherz); (2) coronary sclerosis; (3) calcification of the myocardium; (4) calcification in the annulus fibrosus; (5) calcification in the endocardium; (6) calcification in cardiac aneurysm; (7) calcification of cardiac thrombosis; (8) tumors of the heart and pericardium may show calcification, but these are extremely rare. These various forms are differentiated easily enough pathologically, and most of them are roentgenologically demonstrable. The cause of these various deposits is difficult to determine.

Calcification occurs in *normal* tissues in two locations: bone, and the rare condition of "calcium metastasis."²⁴ In all other locations it is deposited in *abnormal* tissue. For the myocardium Diamond⁹ finds in a recent review of the literature that calcification occurs secondarily to degeneration or necrosis of muscle fibers due to vascular, inflammatory or toxic conditions. The important point is that for tissues in general, degeneration of some sort precedes calcium deposition. The process concerned with this precipitation of calcium is still unknown though many theories of the mechanism have been advanced. Wells²⁴ favors a physicochemical view.

Though no attempt was made to cover the entire literature on the subject of calcification in heart valves, a few opinions may be briefly quoted. These are naturally divided into: (I) those subscribing to Mönckeberg's sclerosis theory; (II) those believing rheumatic fever to be the etiological agent; and (III) those considering the etiological proof indefinite for either of these groups.

I. Mönckeberg,¹⁷ in considering calcification in the aortic valve, concluded that the process was not the result of an inflammatory lesion. He believed that the calcium was deposited in the fibrous tissue

of the valves continuous with the wall of the aorta, and that the cause was a degeneration of the media of the aortic wall. Clark⁶ studied 87 cases of calcareous aortic valvular disease. He excluded 8 cases because of a definite history of rheumatic fever and thought the rest to be upon a degenerative arteriosclerotic basis. Tuohy and Eckman,²³ while admitting that the determinative factors of calcified aortic valves were speculative, accepted Mönckeberg's theory. Martens¹⁵ has recently discussed the relationship between calcification of the annulus fibrosus of the mitral valve, senile endostosis and calcification of the intervertebral discs. These he found to be frequently associated and he believed that inflammation was the cause in some cases. He, however, considered all of these changes to be regressive in character. Geerling¹¹ studied eight hearts post mortem and came to the conclusion that Mönckeberg's ascending sclerosis of the aortic valves was identical with the calcification of the annulus fibrosus of the mitral valves. He considered the process to be due to a compression of the small arteries of the region because of the contractions of the heart muscle resulting in insufficient blood supply, increased connective tissue and finally calcification.

II. Cabot² studied 28 cases of pure aortic stenosis and found that the history of rheumatic fever was as frequent as it was for the cases of rheumatic mitral disease. He would not believe that an arteriosclerotic process would limit itself to one valve and concluded that the lesion was due to rheumatic fever. Christian's⁴ report showed that 11 of his 21 patients with aortic stenosis and calcification had a definite history of rheumatic fever. This led him to the conclusion that the causative factor was in all probability rheumatic fever. Boyd¹ also believed the unproved relationship to be sound.

III. Clawson, Bell and Hartzell⁷ in a study of 15 cases of aortic calcareous nodules could find no evidence in favor of an inflammatory origin. They did find that

the root of the aorta was particularly free from arteriosclerotic change. Thus they considered the etiology as unknown but separate from a rheumatic process. Margolis, Ziellessen and Barnes¹⁴ studied 42 cases of calcareous endocarditis of the aortic valve. Some of their cases seemed to be the result of an inflammatory injury while others seemed to represent the result of a non-inflammatory degenerative process. They concluded that the etiology could not be determined with certainty. Grant, in a recent lecture delivered before the New England Heart Association, stated that the etiology of calcification in the aortic valves is indeterminable. Kaufmann¹² believed that calcification of the annulus fibrosus occurred quite independently from rheumatic fever, but that the calcium deposited never reached the large amounts found to follow an inactive endocarditis. Thalheimer,²² after observing that bacteria never could be found in any of the chronic lesions of valves, believed that the damage was non-bacterial, and he proposed an ingenious theory concerning their development. Infections (scarlet fever, measles, tonsillitis, pneumonia, etc.) resulted in a slight fibrosis of the valves, insufficient to cause signs or symptoms, but enough to reduce the proper resiliency and elasticity of the normal valves. Repeated insults of this nature led to thickening. Any strain upon these valves produced minute thromboses and the resultant fibrosis added to the thickening. These processes could occur again and again, eventually leading to cardiac symptoms and signs. Proof for this mechanism, however, is lacking.

As mentioned above in our cases we were able to get a history of rheumatic fever in 7, possibly 9 of 13 cases of mitral disease. In the aortic group we obtained a history of rheumatic fever in 6 of the 12 cases. Of those that were studied anatomically, 3 had a history of rheumatic fever and one was unconscious making a satisfactory history unobtainable.

As seen at autopsy, the calcium deposit

in the aortic valves varied tremendously in amount. In Case III the aortic valve cusps were thickened. At the junction of the right and left posterior aortic cusps there was a warty calcified mass, 8 mm. in diameter. This small amount of calcium deposit was not visualized by the roentgen ray ante mortem. The mitral valve showed slight insufficiency and stenosis but no calcified areas. The evidence for a rheumatic etiology was considered to be clear cut. In Case VIII the aortic leaflets were converted almost entirely into hard calcified masses. This calcification stopped rather abruptly at the attachment of the cusps to the aortic wall, but a few calcified patches were seen in the sinuses of Valsalva. Above these there was a thin ring of small calcium plaques. The anterior leaflet of the mitral valve showed many small, irregular, yellowish-gray thickenings that were calcified. Slight mitral insufficiency was present but no stenosis. No evidence for an inflammatory origin could be found. In Case XI there was marked thickening and stiffness of the aortic valve near the bases of the cusps which was due to calcium deposit. Irregular, elevated, calcified areas projected into the sinuses of Valsalva. Atheromatous degeneration extended into the aorta as far as the arch. A few small nodules were noted on the auricular surface of the posterior leaflet of the mitral valve. No stenosis or insufficiency was present. The lesion was considered to be questionably of rheumatic origin.

One case of mitral disease (Case XIX) came to autopsy. This case typifies to our mind the findings we believe present in the 9 younger patients as regards the mitral valve. The mitral valve was seen to be typically stenosed with greatly thickened leaflets containing calcium. The aortic valve appeared normal. The lesion was considered to be of rheumatic origin. Cases XIII, XIV and XV would show in addition some involvement of the aortic valve by the rheumatic process as evidenced by the physical signs.

The gross and microscopic pathology resembled exactly the findings completely described by others^{2,6,7,11,12,14,15,17,22,23}. The sections showed the usual areas of hyalinized connective tissue of the subendothelium with irregularly placed areas of calcification. In some cases this was confined to the valve leaflets. In marked cases this might extend beyond the base of the valve into its attachment in the annulus fibrosus.

Our pathological material certainly lends support to the theory of rheumatic etiology of calcified valves. It is impossible to say, however, from this material that previous attacks of rheumatism cause all of the calcified lesions that one encounters. Our series did not include a case of calcification in the annulus fibrosus, typified by the 4 older patients of the mitral group, but on examining old slides, cases were found in which this had occurred. In these cases the valve leaflets were entirely normal. Dr. Wolbach has aptly remarked in discussing the possible etiological factors in these cases that it was difficult to determine the cause of the fire by an examination of the ashes.

ROENTGENOSCOPY

A. *Technique.* As we have pointed out before, the calcification in the valves is most accurately as well as most easily demonstrated by roentgenoscopy. The technique is simple. One needs only to ask himself the question whether there are calcified areas inside the heart and then proceed to look for them. (1) Adequate preparation of the eyes is essential, of course, as in all roentgenoscopic examinations, but particularly when searching for these calcified areas inside the heart. We ordinarily stay fifteen minutes in a completely darkened room, but if the day is bright, or if the observer has been facing bright lights, twenty to thirty minutes is better. One can intersperse these cases during a series of gastrointestinal roentgenoscopies, when the eyes will be well sensitized and the pupils well accommodated. (2) A beam of rays of fairly high penetra-

tion is required, as one must look *through* the heart and not just study its outline by contrast as is usually done. We use a $4\frac{1}{2}$ to 5 inch gap (70-75 kv. self-rectified) with 5 ma. of current which is usually sufficient. In very thick-chested or adipose patients, or in those with unusually large hearts, even more penetration and current may be better. (3) A very small aperture is necessary both to concentrate the attention and to cut down secondary radiation. The size of the field visible on the fluoroscopic screen should not be more than 4 or 5 cm. in diameter when searching for the smaller, less distinct areas of calcification. Many of the larger ones can easily be seen with a field large enough to include the whole heart shadow. With these three precautions, then, it is an easy matter to locate the auriculo-ventricular junction on the left border of the heart, and then search the area below and medial to this following a line 45° from the horizontal, which roughly corresponds to the auriculoventricular junction where the valves are located. It requires only a few seconds to search this region, looking for dark areas which show a dancing movement with each heart beat. (The same technique should be employed when looking for pericardial calcification, for calcified infarcts or aneurysms, and for calcified coronary arteries, only the areas searched are different.) (4) The position of the patient is important, as the dark areas of calcification can best be seen with the patient rotated so that the right shoulder is 15° to 20° forward, a modified right antero-oblique position. Deep inspiration with cessation of breathing also helps to differentiate the dancing intracardiac shadows from other shadows in the lung or mediastinum which move most with respiration, but which may show a slight transmitted pulsation. Pericardial and myocardial calcification show only slight movement.

B. *Movement of Calcified Valves.* These calcified valves uniformly demonstrate a high degree of mobility, moving toward the apex with systole and returning with

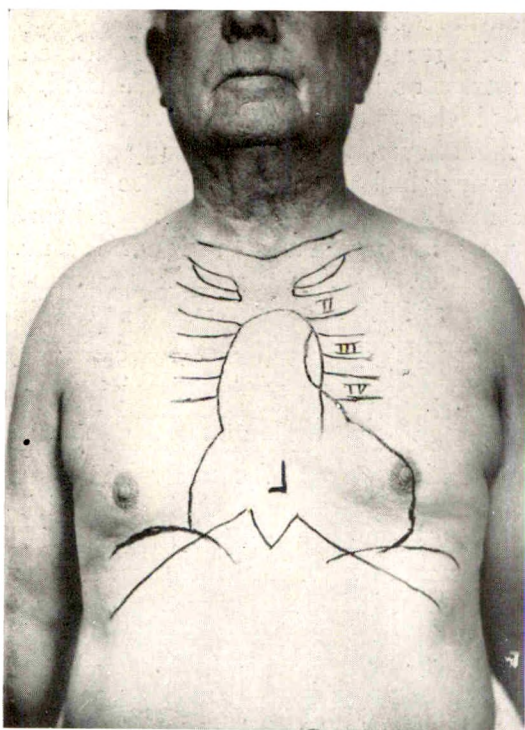


FIG. 1. Orthodiagram traced on patient's chest. Aortic stenosis with calcification (Case XII). Typical silhouette, valve low, almost in midline.

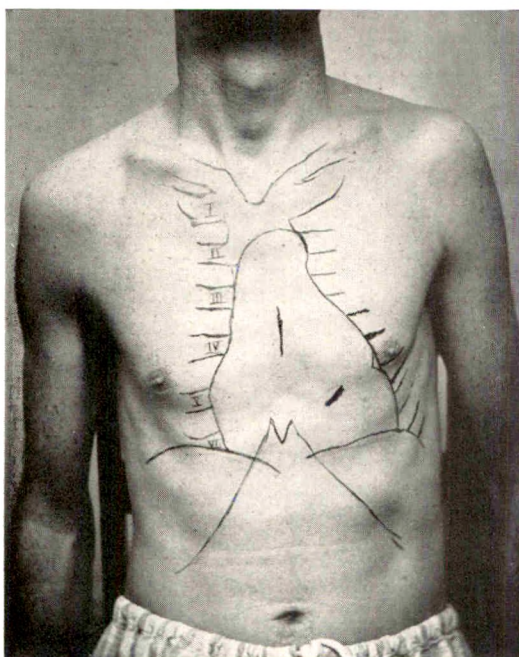


FIG. 2. Orthodiagram in mitral disease with calcification (Case XIV). Typical silhouette, valve low and well to the left.

diastole. The amount of movement is usually greater than that seen at the apex of the heart, and corresponds best to that seen on the posterior aspect of the heart in a marked left antero-oblique view. In only 2 of our cases was the heart so rapid or so irregular that we could not determine the relation of movement to the phase of the heart cycle. In several cases there was a double systolic movement, first downward toward the diaphragm and then toward the apex, with a return in a straight line to the

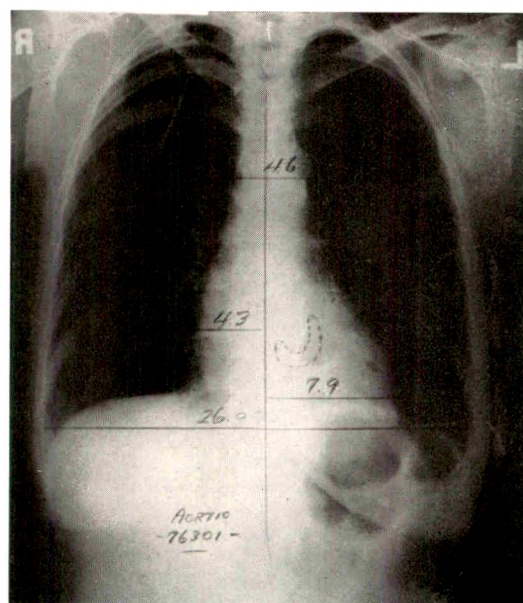


FIG. 3. Aortic stenosis with calcification. Seven-foot film, valve outlined from roentgenoscopic tracings (Case VII).

original position during diastole. This traced a roughly triangular course with the hypotenuse of the triangle formed during diastolic relaxation. In one patient (Case VII) where there were visible several separate distinct areas of calcification, a definite opening and closing was observed, the space between the calcified segments being widened during systole and narrowed during diastole, signifying to us that more than one leaflet of the valve was involved, and that the valve leaflets were still functioning, at least in part, in spite of the sclerosis.

C. *Location.* Most of the calcified aortic valves were located at the left border of the spine in the direct posteroanterior view, usually being hidden in whole or in part by the shadow of the spine and mediastinal contents. Anteroposteriorly they are usually deep in the heart about midway or just behind the center, as seen in an exaggerated left antero-oblique position. By comparison the calcified mitral valves are usually seen well to the left of the spine in the direct posteroanterior view, and lie in

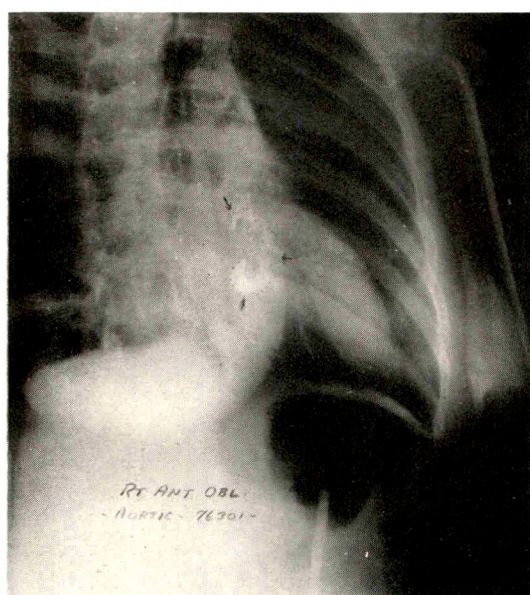


FIG. 4. Same case as Figure 3, right antero-oblique position, short exposure.

the posterior third of the heart shadow in the exaggerated left antero-oblique view, sometimes so close to the posterior wall that they are thought at first to be in the pericardium. This is particularly true of those cases (xxii, xxiii, xxiv, xxv) in which we think the calcification is in the annulus fibrosus of the mitral valve. Figure 1 shows the usual site of the aortic valve and Figure 2 localizes the position of the mitral valve in the straight anterior view.* It is often difficult to demonstrate the lesser

* These photographs were made by Miss Rowell after tracing the outline of the heart upon the patient's chest during roentgenoscopy. A very small fluoroscopic aperture was used, centered at each point on the heart outline as in making an orthodiagram and a skin pencil with a metallic lead sheath was used to mark each

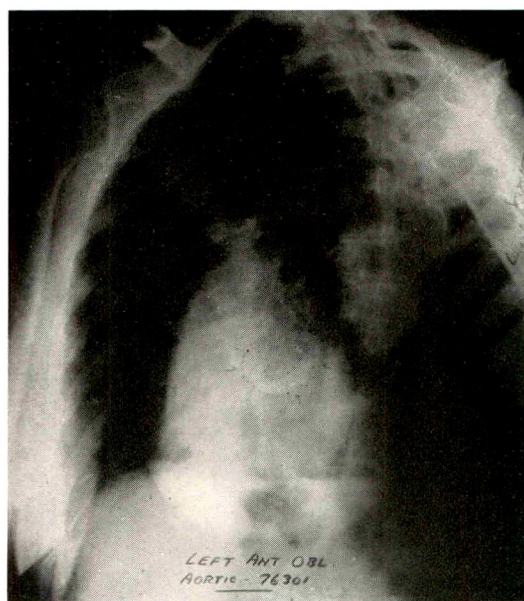


FIG. 5. Same case as Figure 3, left antero-oblique position. Compare these with Figures 6, 7 and 8.

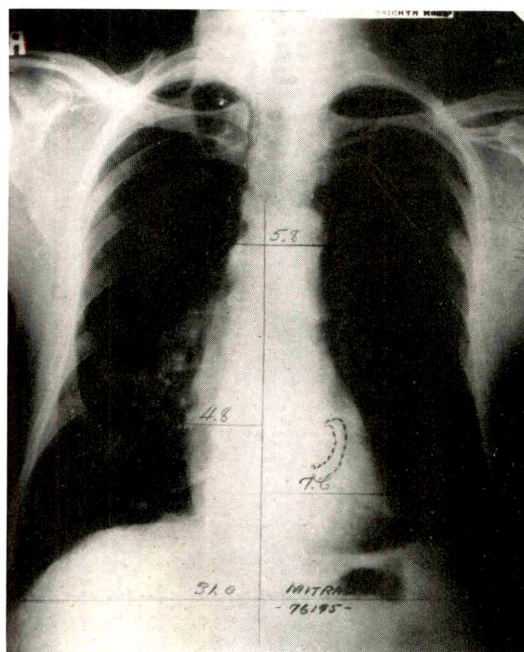


FIG. 6. Calcification in the mitral valve (?annulus fibrosus) (Case xxiv). Seven-foot films, valve outlined from roentgenoscopic tracings.

point. The ribs were sketched in afterward to show their relation to the heart outline. This tracing was of considerable value in teaching and in demonstrations, and was a great help in locating the murmurs and thrills in their relation to the position of the valves. A separate article is being prepared giving a more detailed discussion of the position of these valves in relation to heart outline, chest wall, and location of murmurs and thrills.

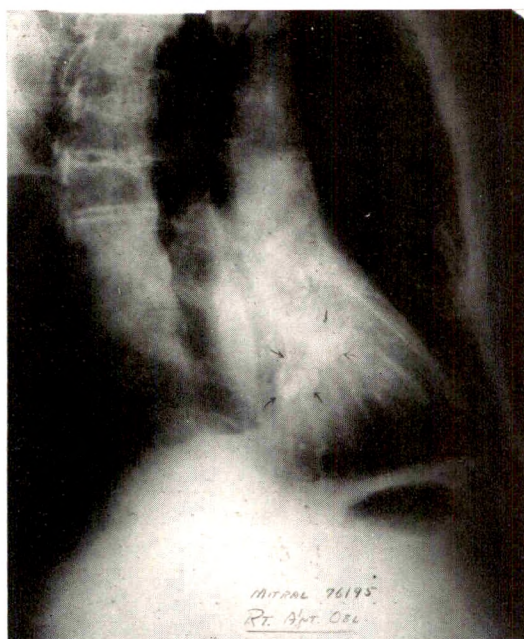


FIG. 7. Same case as Figure 6, right antero-oblique position, short exposure.

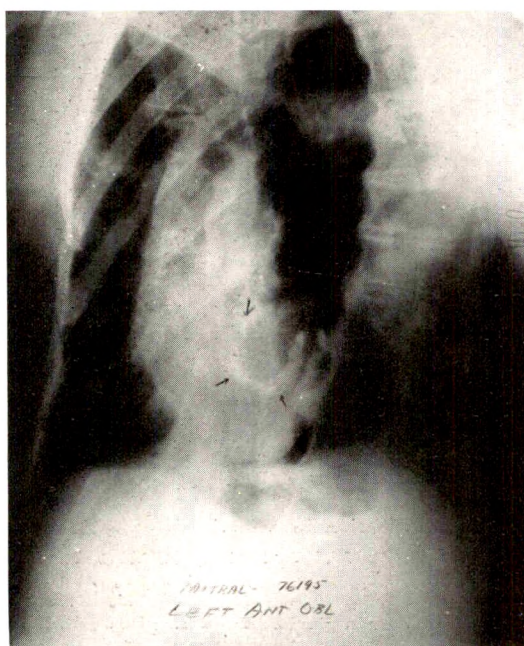


FIG. 8. Same case as Figure 6, left antero-oblique position, short exposure. Posterior limb of calcification near posterior border of heart.

degrees of calcification in the exaggerated left antero-oblique view, as we are looking through the long axis of the heart with the maximum amount of cardiac tissue superimposed.

In the markedly enlarged hearts of mitral disease, the calcified valve may be well to the left of the spine and much more toward the apex of the heart shadow than one would expect, suggesting that by far the greater part of the heart shadow is formed by the enormously dilated auricles.

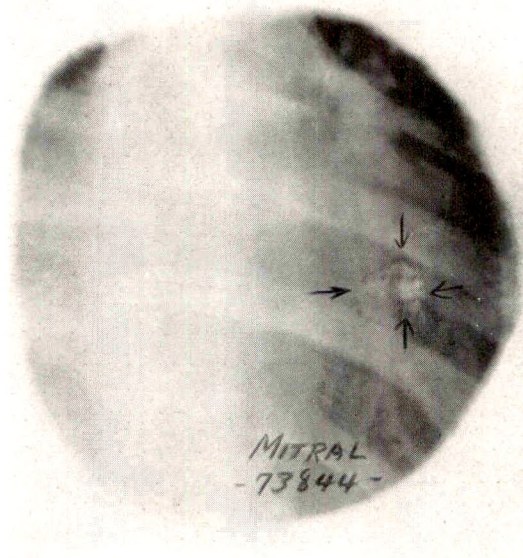


FIG. 9. Calcification in mitral valve, small amount, short exposure, slight right antero-oblique position (Case xv).

D. Confusing Shadows. At roentgenoscopy there is nothing which simulates the dancing shadow of these calcified valves so far as we have seen. Areas of calcification in the mediastinum or lung overlying or behind the heart shadow can be rotated away from the heart in some position or other, and they move very little or not at all with the heart beat, showing their maximum movement upward and downward with respiration. Calcified areas in the pericardium usually can be located in the same manner, by rotating the patient gradually through a complete circle, or

even 180° , which usually is sufficient. Their motion is decidedly less than that of the valves in systole and diastole. The shape of the calcified areas may be of help in differentiation, those in the valves usually being C-shaped or J-shaped, while those in the pericardium are linear or branching. Calcified myocardial areas may be large and single or multiple and diffuse. We have

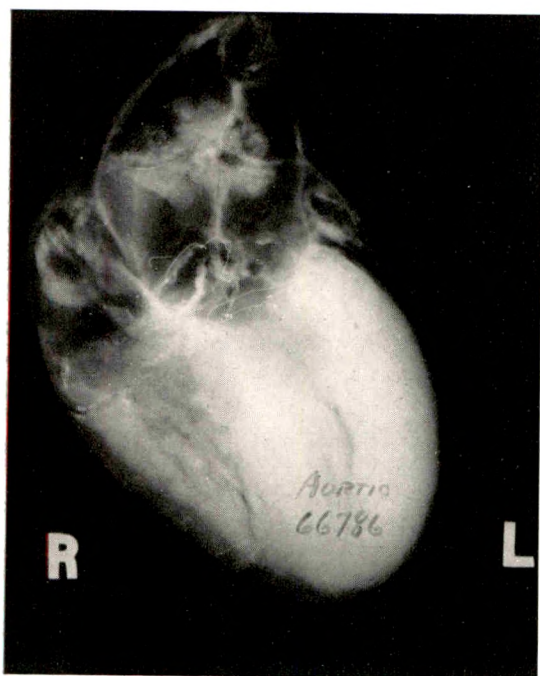


FIG. 10. Roentgenogram of heart post mortem. Upper left wire at attachments of aortic valve, calcification in valve leaflets, in bead-like strings (Case XI). Also slight calcification in mitral valve and in coronary arteries. Note that ventricles form most of heart shadow, compared to Figure 11, where auricles predominate.

not observed calcification in a tumor of the heart except after autopsy.

ROENTGENOGRAPHY

On the films the most confusing shadows are those of the calcified costal cartilages so common in older people. These may be so extensive and so marked that it is impossible to be certain of the shadow of calcified valves which were seen clearly during roentgenoscopy. Here, too, calcified glands and calcified areas in the lung may be con-

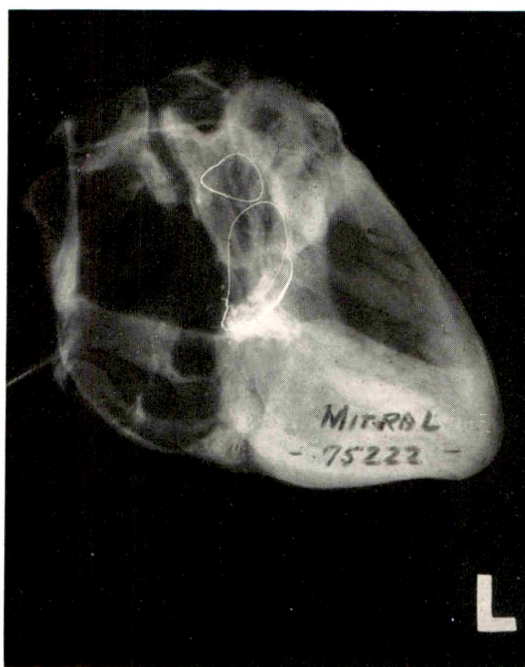


FIG. 11. Roentgenogram of heart post mortem. Fine wires at attachments of valves, lower-mitral, upper-aortic. Metal strip in narrow orifice of mitral valve (Case XIX).

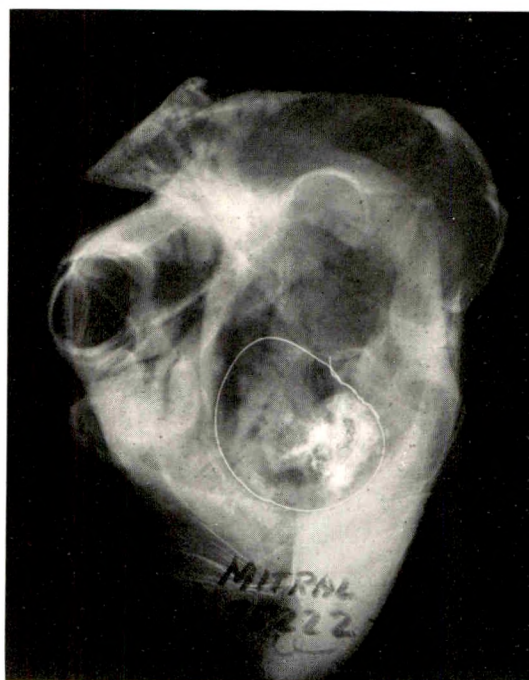


FIG. 12. Same case as Figure 11, viewed from above. Calcification almost entirely in posterior leaflet of mitral valve.

fused with the shadows cast by the calcified valves. In our department we depend upon the roentgenoscopic examination for the demonstration of the presence of calcification, using the film method only to check the amount and distribution of the calcification and to furnish a permanent record for demonstration. Tracings of the heart shadow and of the areas of calcification may be made at roentgenoscopy either upon washed films or directly upon the patient's chest, as noted above. The latter method is not of value in women, as the breasts interfere with the accurate outlining of the heart shadow. Before making roentgenograms we mark the spot on the patient's chest where the valve is best seen, both front and back, as in locating foreign bodies. This enables the technician to use a small cone, and, by getting the two points in line, to duplicate the position in making films. For the latter, speed is essential, the exact speed depending upon the heart rate, the faster the heart rate the shorter the exposure must be. We have obtained excellent roentgenograms in one-tenth of a second, but more commonly one-thirtieth of a second has been necessary. Our maximum milliamperage is 200, distance 30 inches, using fast screens and speed films, and a "dental cylinder" directed at the spots marked on the patient's skin. It should be easier to demonstrate these calcified valves with a 1000-milliamper machine. An elaborate relay such as that described by McPhedran and Weyl¹⁶ is not necessary provided a sufficiently short exposure can be made which will penetrate the heart shadow. A Potter-Bucky diaphragm such as that made by Lysholm may be used advantageously in roentgenoscopy, but it requires almost double the current, and for this reason should not be of advantage in roentgenography where speed is essential. The small cone (diam. 7.5 cm., length 25 cm.) in fact cuts down the secondary rays and thus acts like the Potter-Bucky grid. Obviously the film must be over-exposed so that the rays will go through the heart, showing it only as a

gray background with the white areas of calcification standing out clearly. These are usually finely granular in appearance and closely packed, although sometimes separate masses may be seen. A roentgenographic study of hearts removed at post-mortem examination will give one a good idea of what to expect.

CASE SUMMARIES OF AORTIC DISEASE

CASE I. F.T.⁵ (X-ray No. 67360), an engineer, aged fifty-three, entered the hospital complaining of shortness of breath and nervousness of five years' duration. He had had rheumatic fever at twelve years of age. Clinically he showed a slightly enlarged heart. The heart sounds were of moderate intensity and the first sound was obliterated by a blowing systolic murmur heard all over the precordium but loudest at the base in the aortic area where a thrill was palpable. There was a blowing diastolic murmur at the base. The blood pressure was 120/65. The lungs showed slight dullness at both bases posteriorly with rather loud crackling râles. The legs showed slight pitting edema. From the clinical signs aortic stenosis with calcification of the aortic valve was predicted.

Roentgen examination on February 27, 1931, showed the heart to be moderately enlarged, chiefly to the left. The aorta was tortuous. The measurements were: median right, 4.8 cm.; median left, 11.0 cm.; great vessels, 6.0 cm.; internal diameter of chest, 29.0 cm. Roentgenoscopy showed multiple areas of calcification in the region of the aortic valve which moved toward the apex of the heart with systole and away from it in diastole, the total excursion being about 0.5 cm. The beat was regular and of good quality, and not exaggerated as in aortic insufficiency.

Diagnosis: Valvular disease, combined chronic cardiac; aortic stenosis and insufficiency; calcareous aortic valvular disease.

CASE II. S.S. (X-ray No. 69918), a carpenter, aged fifty-six, entered the hospital complaining of a severe cough and dyspnea on slight exertion for six months. The past history revealed a fever of unknown origin in childhood, but no specific history of rheumatism could be obtained. Clinically the patient showed an enlarged heart. The rhythm was completely irregular. There were no murmurs and no thrills. The first sound was split at the apex. The blood

pressure was 160/104. Cardiac decompensation was marked. (The earlier records of this patient, when the heart rhythm was regular, revealed that a presystolic rumble had been heard at the apex.)

Roentgen examination on November 1, 1932, showed the heart to be enlarged both to the right and left with no fullness in the region of the left auricle. Roentgenoscopy showed scattered irregular areas of calcification just to the left of the midline in the region of the aortic valve moving toward the apex with each systole. The patient died but autopsy was not permitted. (This patient had been roentgenoscoped twice before in this department in 1931 by assistants who did not look for calcified valves and who did not therefore find them.)

Diagnosis: Valvular disease, combined chronic cardiac, mitral stenosis and insufficiency; calcareous aortic valvular disease; auricular fibrillation; bronchopneumonia.

CASE III. E.A. (X-ray No. 76922), a cook, aged fifty-six, entered the hospital complaining of shortness of breath for two months. He had had rheumatic fever at fourteen years of age. Clinically he showed an enlarged heart. The rhythm was totally irregular. There were systolic and diastolic murmurs at the base and at the apex. There was a systolic thrill at the base. The blood pressure was 180/95. There were slight signs of cardiac insufficiency.

Roentgen examination disclosed no areas of intracardiac calcification but these were suspected clinically. There was definite cardiac enlargement both to the right and left with some fullness in the left auricular region. The measurements were: M.r., 6.8 cm.; M.l., 10.2 cm.; G.V., 5.7 cm.; Int. Dia., 29.8 cm.

The patient died suddenly. Post-mortem roentgen examination of the heart revealed calcification in the coronary arteries and in the aortic valve cusps, the latter forming a finely mottled irregular mass 1.5×3.0 cm. in size, limited to the two posterior cusps and not extending onto the wall of the aorta or into the myocardium.

At autopsy the heart weighed 680 grams. The tricuspid and pulmonary valves appeared normal. The *mitral valve* admitted two finger tips and was considered to be slightly stenosed. The valve leaflets were shortened and moderately thickened at the margins. There were no vegetations or atheromatous plaques on the leaflets. The chordae tendinae were hypertrophied and shortened. There was slight fusion of the

mitral valve cusps. The valve was not rigid but had slight impairment in its competence. The *aortic valve* showed moderate stenosis and marked insufficiency. The cusps were thickened, rigid and hardened. At the junction of the right and left posterior aortic cusps there was a warty calcified mass approximately 8 mm. in diameter. The sclerotic changes were confined almost entirely to the cusps and their bases. The sinuses of Valsalva were uninvolved. The corpora Arantii were thickened and nodular. The coronary arteries showed marked sclerosis and the right coronary artery was occluded. Microscopically a slight infiltration of lime salts was noted at the base of mitral valve.

Diagnosis: Valvular disease; combined chronic cardiac; aortic stenosis and insufficiency, marked; calcareous aortic valve disease; mitral stenosis and insufficiency, slight; coronary sclerosis, marked; cardiac infarction; myocardial fibrosis; arteriosclerosis, generalized.

CASE IV. F.C. (X-ray No. 76098), a male clerk, aged fifty-nine, entered the hospital complaining of dyspnea on exertion of two months' duration. There was no past history of rheumatic fever or allied conditions obtainable. Clinically his heart was enlarged. There was a loud systolic murmur in the aortic area transmitted upward and accompanied by a thrill. There was no diastolic murmur heard. The blood pressure was 112/100. The liver was palpable and tender. There were moist râles at both bases of the lungs. There was edema of the ankles. There were marked evidences of Paget's disease.

Roentgen examination on December 20, 1932, showed definite cardiac enlargement downward and to the left with no mitral fullness. The aorta was not enlarged. The measurements were: M.r., 4.5 cm.; M.l., 12.6 cm.; G.V., 5.6 cm.; Int. Dia. 29.4 cm. Roentgenoscopy showed a vigorous ventricular pulsation, but a small aortic pulsation, the latter definitely less than normal. There was an irregular mass of calcification deep in the heart at the left border of the spine measuring 2.5×4 cm. in size and shaped like an inverted "C." It moved sharply toward the apex of the heart with systole. This was in the region of the aortic valve.

Diagnosis: Valvular disease, chronic cardiac, aortic stenosis; calcareous aortic valvular disease; Paget's disease.

CASE V. E.B. (X-ray No. 75945), a housewife, aged sixty, entered the Out-Door Department

complaining of a toothache. There was no past history of rheumatic fever or allied conditions obtainable. Clinically her heart was enlarged. There was a systolic murmur and thrill at the base. There was no diastolic murmur. The blood pressure was 200/110. There were no signs of cardiac insufficiency.

Roentgen examination on December 7, 1932, showed the heart to be enlarged to the left with a rounded, blunt left ventricle. The aorta was tortuous and there was marked calcification in the arch. The measurements were: M.r., 4.3 cm.; M.l., 8.7 cm.; G.V., 5.6 cm.; Int. Dia., 24.2 cm. Roentgenoscopy showed a regular sustained beat with calcification deep in the heart just to the left of the spine in the aortic valve.

Diagnosis: Valvular heart disease, chronic cardiac, aortic stenosis; calcareous aortic valvular disease.

CASE VI. W.A. (X-ray No. 70214), a male music teacher, aged sixty-three entered the hospital complaining of substernal burning and eructation of gas for years, worse in the past two months. There was no past history of rheumatism or allied conditions. Clinically the patient showed a slightly enlarged heart with a loud systolic murmur over the precordium, loudest at the base where a systolic thrill was noted. No diastolic murmur was heard. The blood pressure was 160/110. Roentgen examination showed a complete pyloric obstruction due to an annular carcinoma. This was confirmed at operation and the carcinoma was resected, with uneventful recovery.

During a follow-up examination of the stomach on November 16, 1931, roentgenoscopy showed calcification deep in the heart in the region of the aortic valve, the calcified areas moving toward the apex with systole. The heart showed marked rounding and blunting of the left ventricle. There was marked tortuosity of the aorta. The measurements were: M.r., 6.1 cm.; M.l., 9.2 cm.; G.V., 7.2 cm.; Int. Dia., 29.2 cm.

The patient was admitted to the hospital two months later because of decompensation. He died one month later but autopsy permission was denied.

Diagnosis: Valvular disease, chronic, cardiac, aortic stenosis; calcareous aortic valvular disease; carcinoma of the stomach with metastases.

CASE VII. L.E. (X-ray No. 76301), a housewife, aged sixty-eight, entered the Out-Door Department complaining of gas after meals for

one month and increasing dyspnea for two years. There was no past history of rheumatic fever or allied conditions obtainable. Clinically there was no enlargement of the heart. There was a rough systolic murmur heard all over the precordium, loudest at the base. There was no thrill or diastolic murmur noted. The blood pressure was 110/68. The liver was slightly enlarged but there were no other signs of cardiac failure.

Roentgen examination on January 9, 1933, showed no enlargement of the heart or abnormality in contour. The measurements were: M.r., 4.3 cm.; M.l., 7.9 cm.; G.V., 4.6 cm.; Int. Dia., 26.0 cm. Roentgenoscopy showed a large, dense, irregular area of calcification deep in the heart overlying the left edge of the spine in the anteroposterior view and in the posterior third of the heart in the region of the annulus fibrosus. The calcification covered an area 3.5 X 4 cm. in size and roughly was annular and in three segments. The left anterior segment moved most, and there was definite opening and shutting of the space between the segments synchronous with the heart beat.

Diagnosis: Valvular disease, chronic cardiac, aortic stenosis; calcareous aortic valvular disease.

CASE VIII. G.C. (X-ray No. 20767), a watchman, aged sixty-nine entered the hospital complaining of severe mid-epigastric pain for ten hours. He gave a history of chorea at nine years of age. Clinically he showed a slightly enlarged heart and a systolic thrill at the base. There was a loud harsh systolic murmur heard over the precordium but most marked at the base. A faint early diastolic murmur was heard along the left sternal margin. The blood pressure was 180/80. There were no signs of cardiac failure. The abdomen was boardlike with generalized tenderness.

Seven months previously the patient had been in the hospital complaining of upper abdominal pain. Roentgen examination then on March 3, 1931, showed definite cardiac enlargement, more to the left than to the right. The measurements were: M.r., 4.9 cm.; M.l., 10.8 cm.; G.V., 6.0 cm.; Int. Dia., 29.1 cm. The aorta was tortuous. There were three distinct areas of intracardiac calcification seen in the position of the aortic valve.

The patient was operated upon and a gangrenous ruptured gallbladder was found causing the generalized peritonitis present. Bronchopneumonia developed and the patient died.

Post-mortem roentgen examination of the heart showed multiple irregular separate areas of calcification involving all three aortic cusps and the anterior mitral cusp.

At autopsy the heart weighed 460 grams. The heart was roughly triangular in shape and enlarged chiefly as the result of left ventricular hypertrophy. The tricuspid and pulmonary valves were normal. The anterior leaflet of the *mitral valve* showed patchy, firm, raised, yellowish-gray thickenings which were irregular in shape, hard, and when cut, were found to be calcified. The calcification extended from the mid-portion of the mitral ring over the anterior cusp down through the leaflet as far as the free margin, and was there more marked and extensive than at any portion of the leaflet. The posterior leaflet and mitral ring above the valves were free from calcified plaques. The *aortic valve* showed an extensive degree of calcification which was associated with definite stenosis. All three leaflets were thickened, rigid, and stood out from the wall of the aorta for a distance varying from 4 to 6 mm. In the valves there were numerous irregular, raised, extremely hard, calcified masses. The calcification was most marked in the anterior aortic leaflet which was seen in one place to measure 6 mm. in thickness. The calcification stopped rather abruptly at the attachment of the leaflets to the aortic wall and only a few small, round, calcified patches were found in the sinuses of Valsalva. About the aortic ring, at the upper margin of the sinuses there was a thin ring of small calcified plaques which varied from 1-2 mm. in diameter. When viewed from above the aortic orifice was seen to be a narrow three-sided slit measuring 7 mm. at its widest portion.

Diagnosis: Valvular disease, combined chronic cardiac, aortic stenosis and insufficiency; aortic valvular calcification; mitral calcification (anterior leaflet); mitral insufficiency with bronchopneumonia and generalized peritonitis as causes of death.

CASE IX. W.T. (X-ray No. 62144), a lawyer, aged seventy, entered the hospital because of mental changes of three weeks' duration. The history was obtained from his wife and no past history of rheumatic fever could be disclosed. Clinically he showed an enlarged heart. There was a systolic murmur heard over the entire precordium becoming loud, rough and high-pitched at the base where a systolic thrill was felt. No diastolic murmur was heard. The blood

pressure was 140/80. There were moist râles in the bases and the liver was palpable 3 cm. below the costal margin.

Roentgen examination on September 19, 1932, revealed definite cardiac enlargement chiefly to the left with a prominent and rounded left ventricle. The aorta was tortuous. The measurements were: M.r., 6.2 cm.; M.l., 10.2 cm.; G.V., 6.1 cm.; Int. Dia., 30.0 cm. Roentgenoscopic examination showed an irregular mass of calcification in the region of the aortic valve. This moved toward the apex with systole. There was marked calcification in the arch of the aorta.

Diagnosis: Valvular disease, chronic cardiac, aortic stenosis; calcareous aortic valvular disease.

CASE X. H.W. (X-ray No. 54714), a nurse, aged seventy, complained of high blood pressure for sixteen years. She gave a history of severe "growing pains" in childhood, yearly attacks of tonsillitis, and severe rheumatism at forty-seven years of age. Clinically she showed an enlarged heart. There was a blowing systolic murmur heard over the precordium getting very rough at the base where a short thrill was felt. There was no diastolic murmur. The blood pressure was 190/90. There were no signs of cardiac failure. The heart measurements from a 7-foot film were: M.r., 5.3 cm.; M.l., 8.5 cm.; G.V., 5.7 cm.; Int. Dia., 22.0 cm.

Roentgenoscopic examination on May 2, 1932, showed a large U-shaped area of intracardiac calcification which moved toward the apex with systole. It appeared nearer the apex and more posterior than the expected position of the aortic valve, but its location was deeper in the heart than pericardial calcification would be. Fast films confirmed this finding showing the calcified area forming three-quarters of a ring, measuring 4 cm. in diameter and lying 1.5 cm. distant from the posterior pericardium.

Diagnosis: Valvular disease, chronic cardiac, aortic stenosis; calcareous aortic valvular disease.

CASE XI. C.W. (X-ray No. 66786), a cleaner, aged seventy-two, was brought to the hospital because of unconsciousness of six hours' duration. There was no past history of rheumatic fever or allied conditions obtainable. Clinically his heart was enlarged and there was a slight systolic thrill at the base. A loud blowing systolic murmur was heard all over the precordium which became harsh over the aortic area and was transmitted into the vessels of the

neck. There was no diastolic murmur auscultated. The blood pressure was 180/96. The liver was easily palpable and there were moist râles at the bases of the lungs.

Roentgen examination at this admission was not possible. Eleven months previously a 7-foot film of the heart showed cardiac enlargement both to the right and left. The measurements were: M.r., 6.1 cm.; M.l., 10.6 cm.; G.V., 8.1 cm.; Int. Dia., 31.0 cm. The aortic shadow appeared widened and tortuous.

The patient died without regaining consciousness. On December 15, 1932, before the autopsy, films of the chest were taken and these showed that calcification was present in the region of the aortic valve. Post-mortem roentgen studies of the heart showed multiple small dense areas of calcification in the three aortic valve cusps and a small amount on the wall of the aorta and a third area in the posterior mitral cusp. The areas in the aortic cusps were dense, finely granular and presented an appearance like several strings of beads.

At autopsy the heart weighed 740 grams. The tricuspid and pulmonary valves were normal. On the anterior leaflet of the *mitral valve* there was a yellowish area of atheromatous degeneration containing, as far as could be determined, no calcium. There was a small area of calcium deposition in the substance of posterior leaflet. There was no evidence of stenosis or insufficiency. The *aortic valve* was exposed from above. The orifice admitted the tip of one small finger. The valve cusps were moderately rigid due to a deposition of calcium. The free margins of the cusps were fairly pliable. The deposition of calcium with thickening of the valve cusps was, for the most part, adjacent to the bases of the cusps or in the mid-portion. The elevated, irregular, calcified areas projected into the sinuses of Valsalva and resembled healed vegetations. The calcification above the valve cusps was of the type due to atheromatous degeneration and was continued so as to involve the intima of the arch of the aorta.

Diagnosis: Valvular disease, chronic cardiac, aortic stenosis; calcareous aortic valvular disease; calcareous mitral valve disease; cardiac hypertrophy and dilatation; questionable healed rheumatic heart disease. The cause of death was a thrombosis of the left internal carotid and middle cerebral arteries.

CASE XII. G.S. (X-ray No. 19842), a printer, aged seventy-two, entered the hospital complaining of shortness of breath for two months.

He was seen when fifty-six years old and treated for general paresis, the symptoms of which did not progress after that time. There was no history of rheumatic fever or allied conditions. Clinically he showed an enlarged heart. There was a systolic murmur at the apex but loudest at the base where there was a systolic thrill. There was no diastolic murmur. The blood pressure was 115/50. There were no signs of cardiac failure not accounted for by the marked secondary anemia present.

Roentgen examination on March 7, 1933, showed definite cardiac enlargement. The aorta was tortuous. The measurements were: M.r., 5.4 cm.; M.l., 10.7 cm.; G.V., 7.0 cm.; Int. Dia., 30.5 cm. There were multiple small areas of calcification deep in the heart close to the mid-line of the sternum. These showed a constant dancing movement toward the apex with systole. Their excursion was greater than the excursion of the apex of the heart. The calcified areas were in the region of the aortic valve.

Diagnosis: Valvular disease, chronic cardiac, aortic stenosis; calcareous aortic valve disease; anemia, secondary; general paresis, arrested. Subsequent examinations showed the cause of the secondary anemia to be an inoperable carcinoma of the stomach.

CASE SUMMARIES OF MITRAL DISEASE

CASE XIII. A.S. (X-ray No. 74692), a housewife, aged twenty-four, entered the hospital because of hemoptysis. She had had attacks of tonsillitis but no history of rheumatism or chorea could be obtained. Clinically she showed signs of a pulmonary abscess which was confirmed by roentgen examination. Her heart was enlarged. There were systolic and diastolic murmurs at the apex. There was a diastolic murmur at the base. There was no thrill at the apex. The blood pressure was 118/50. There were no signs of cardiac failure. The patient was well enough for a thorough roentgenoscopic examination on October 14, 1932, and the heart was noted as enlarged with fullness on the left border in the region of the left auricle. A small area of calcification was noted in the region of the mitral valve.

The pulmonary abscess healed under medical treatment and the patient was discharged.

Diagnosis: Valvular disease, combined chronic cardiac, mitral stenosis and insufficiency, aortic insufficiency; calcareous mitral disease; abscess of the lung.

CASE XIV. H.A. (X-ray No. 75905), a mail

clerk, aged thirty-three, entered the hospital complaining of pounding of the heart for four years. The patient had had tonsillitis several times, chorea at ten years, and rheumatic fever at seventeen years. Clinically he showed an enlarged heart and slight precordial bulging. A loud blowing systolic murmur obliterated the first sound and a rumbling diastolic murmur followed an indistinct second sound at the apex. There were systolic and diastolic murmurs at the base. A diastolic apical thrill was felt. The rhythm was grossly irregular. The blood pressure was 115/75. There were no signs of cardiac failure. Roentgen examination on December 6, 1932, showed definite cardiac enlargement, both to the right and left. There was marked fullness of the left auricle which projected backwards into the posterior mediastinum, displacing the esophagus backward. Roentgenoscopy showed calcification well to the left of the spine, deep in the heart opposite the auriculoventricular groove, in the area of the mitral valve, with sharp movements toward the apex with systole.

Diagnosis: Valvular heart disease, combined chronic cardiac, aortic insufficiency, mitral stenosis and insufficiency; calcareous mitral disease; auricular fibrillation.

CASE XV. S.J. (X-ray No. 73844), a shoe salesman, aged thirty-six, entered the hospital complaining of pain in the left upper quadrant for one day. He had had rheumatic fever at eighteen years and had been under observation in this hospital for ten years. Clinically he showed an enlarged heart with systolic and diastolic murmurs at the apex and base. There was a systolic thrill at the base and at the apex. The rhythm was absolutely irregular. The blood pressure was 116/94. The liver was palpable but there were no signs of cardiac insufficiency. A roentgen examination for the first time on June 24, 1932, showed marked cardiac enlargement both to the right and left with considerable prominence of the left auricle which projected back into the mediastinum and extended to the right of the midline. The esophagus was displaced to the right. The measurements were: M.r., 8.5 cm.; M.l., 10.9 cm.; G.V., 4.2 cm.; Int. Dia. chest, 25.6 cm. Roentgenoscopy showed a definite irregular area of calcification 1.5×2.5 cm. in size in the region of the mitral valve. This moved toward the apex with systole.

Diagnosis: Valvular disease, combined chronic cardiac with mitral stenosis and insufficiency

and aortic insufficiency; calcareous mitral disease; auricular fibrillation; pleurisy, acute fibrinous.

CASE XVI. M.D. (X-ray No. 75517), a female clerk, aged thirty-eight, entered the Out-Door Department complaining of marked fatigue. She had had rheumatic fever three times at eight, eleven and fifteen years of age. Clinically she showed systolic and diastolic murmurs at the apex. There were no murmurs at the base. The rhythm was regular. No thrills were palpated. The blood pressure was 130/90. There were no evidences of cardiac failure. Roentgenoscopic examination on November 5, 1932, showed a small area of calcification in the mitral valve, moving toward the apex with each systole.

Diagnosis: Valvular disease, chronic cardiac, mitral stenosis and insufficiency; calcareous mitral disease.

CASE XVII. H.C. (X-ray No. 76415), a male clerk, aged thirty-eight, entered the hospital complaining of shortness of breath and palpitation for two years. He had had rheumatic fever at twenty-seven years of age. Clinically he showed both systolic and diastolic murmurs at the apex. There were no basal murmurs or thrills over the precordium. The rhythm was grossly irregular. The blood pressure was 130/75. The liver was markedly enlarged and there were râles at the lung bases. Roentgen examination on January 17, 1933, showed marked cardiac enlargement, both to the right and left with dilatation of both auricles. Roentgenoscopy showed a J-shaped area of calcification deep in the heart overlying the left border of the spine with the dancing movements at each cardiac contraction, located in the region of the mitral valve.

Diagnosis: Valvular disease, chronic cardiac, mitral stenosis and insufficiency; calcareous mitral disease; auricular fibrillation.

CASE XVIII. H.B. (X-ray No. 75778), a shoe salesman, aged forty-two, entered the hospital complaining of swelling of the legs for four months. He had had rheumatic fever at seventeen and again at twenty years of age. Clinically he showed marked cardiac enlargement. There were systolic and diastolic murmurs at the apex, but not heard at the base. There were no thrills palpated. The rhythm was grossly irregular. The blood pressure was 145/100. There was marked edema of the ankles, the liver was palpable, and there were râles at both bases. Roentgen examination on November 25,

1932, showed marked cardiac enlargement both to the left and right with definite fullness in the region of the left auricle and apparent dilatation of the right auricle. The measurements were: M.r., 7.7 cm.; M.l., 13.5 cm.; G.V., 6.0 cm.; Int. Dia., 29.6 cm. Roentgenoscopy showed an irregular area of calcification inside the heart, well to the left of the spine and well posterior, moving toward the apex with each systole.

Diagnosis: Valvular disease, chronic cardiac, mitral stenosis and insufficiency; calcareous mitral valvular disease; auricular fibrillation.

CASE XIX. J.E. (X-ray No. 75222), a machinist, aged forty-four, entered the hospital complaining of dyspnea and precordial pain of five and one-half years' duration. He had had rheumatic fever at twenty-two years of age. Clinically he showed a slightly enlarged heart. The heart sounds were of good quality. There was a mid-diastolic rumble at the apex accompanied by a thrill. A faint systolic murmur followed the first sound. There were no murmurs at the base. The rhythm was grossly irregular. The blood pressure was 118/70. There were a few crackles at both bases but otherwise no signs of cardiac failure. Roentgen examination on October 18, 1932, showed the heart slightly enlarged in the transverse diameter with definite prominence in the region of both auricles which projected backward into the posterior mediastinum, displacing the esophagus backward and to the right. The measurements were: M.r., 5.9 cm.; M.l., 8.2 cm.; G.V., 4.4 cm.; Int. Dia. chest, 27.6 cm. Roentgenoscopy showed definite irregular nodular calcification deep in the heart, probably in the mitral valve. This moved toward the left and toward the apex with systole. The patient died twenty-six hours after cardiectomy and valvulotomy. Post-mortem films of the heart showed a triangular mass of calcium $2.2 \times 2.1 \times 1.7$ cm. in size in the posterior leaflet of the mitral valve and extending into the myocardium. The calcium deposit was finely granular and irregular, not beaded or in streaks.

At autopsy the heart weighed 620 grams. It was fixed after the method of T. Lewis and windows cut so as to give a view of the valves. The auricles constituted roughly two-thirds of the specimen. The left ventricle appeared normal. The left auricle was capacious. The mitral valve measured 3×3.5 cm. Its leaflets were greatly thickened and calcareous at the posterior limits. The orifice was 1 cm. long by 2 mm. wide, fish-mouthed and sclerosed, a typical completely stenotic valve. The margins of the

valve leaflets were firm, irregular and calcified.

Diagnosis: Valvular heart disease, combined chronic cardiac, mitral stenosis and insufficiency; calcification of the mitral valve; cardiac hypertrophy and dilatation; fibrinous pericarditis; pulmonary arteriosclerosis; pulmonary congestion and edema; bronchopneumonia.

CASE XX. C.B. (X-ray No. 55413), a housewife, aged fifty-two, entered the hospital complaining of a dull pain over the precordium, in the left axilla, and left upper quadrant of three days' duration. Through language difficulties no definite history of rheumatism could be obtained but she did remember tender swollen ankles as a child. Clinically she showed an enlarged heart with systolic and diastolic murmurs at the apex. There were no murmurs at the base. The rhythm was grossly irregular. The blood pressure was 118/78. There were slight signs of cardiac failure. During roentgen examination of her gastrointestinal system on November 3, 1932, roentgenoscopy showed an enlarged heart with intracardiac calcification almost 5 cm. to the left of the midline and located posteriorly in the heart. This moved toward the apex with systole and was in the region of the mitral valve. Subsequently this patient had numerous embolic phenomena interpreted as coming from the heart.

Diagnosis: Valvular disease, combined chronic cardiac, mitral insufficiency and stenosis; calcareous mitral valvular disease; auricular fibrillation; infarct of lungs, kidneys, spleen, right cerebrum.

CASE XXI. J.M. (X-ray No. 56352), a caterer, aged fifty-six, entered the hospital complaining of pain in the left back and groin of five weeks' duration. He had had rheumatic fever at twenty years of age. Clinically he showed an enlarged heart. Both systolic and diastolic murmurs were heard at the apex. No murmurs were heard at the base. There was no thrill. The rate was grossly irregular. The blood pressure was 165/80. There was no evidence of cardiac failure. Roentgen examination on December 19, 1932, showed an enlarged heart with prominences in the region of the right and left auricles. The measurements were: M.r., 5.5 cm.; M.l., 10.6 cm.; G.V., 6.2 cm.; Int. Dia., 28.3 cm. Roentgenoscopy showed definite irregular areas of calcification deep in the heart to the left of the spine in the region of the mitral valve. Films showed other doubtful areas of calcification.

Diagnosis: Valvular disease, chronic cardiac, mitral stenosis and insufficiency; calcareous mitral valvular disease; renal calculus; cholelithiasis; auricular fibrillation.

CASE XXII. E.D. (X-ray No. 75774), a constable, aged fifty-eight, entered the hospital complaining of shortness of breath for nine months. The patient had had scarlet fever in childhood. There was no history of tonsillitis, chorea or rheumatism. Clinically the patient had an enlarged heart. The heart sounds were faint and there were no murmurs. The rhythm was grossly irregular. There were no thrills. The blood pressure was 105/60. The liver was enlarged. There was free fluid in the chest. A roentgen examination on November 25, 1932, confirmed the presence of fluid in the chest cavities. The heart was enlarged to the left and right, was irregular in outline and indistinct. Roentgenoscopy showed a rapid, completely irregular beat with marked prominence of the left auricle posteriorly. An irregular mass of calcification was seen well posterior in the heart, 1×3 cm. in size and well to the left of the spine. This moved toward the apex with systole.

Diagnosis: Chronic myocarditis; auricular fibrillation; calcification of the annulus fibrosus of the mitral valve.

CASE XXIII. R.N. (X-ray No. 4371), a housewife, aged seventy-two, entered the Out-Door Department complaining of epigastric distress and dyspnea on exertion. She had been under observation at this hospital for seventeen years. She gave no history of rheumatic fever or allied conditions. Clinically her heart was enlarged. There was a rough systolic but no diastolic murmur heard at the apex. The heart sounds were very faint at the base where no murmurs were heard. There was no thrill palpated. The blood pressure was 190/74. There were no signs of cardiac failure. On June 7, 1932, during a gastrointestinal examination, a definite area of calcification was seen in the heart roentgenoscopically near the posterior border just to the left of the spine in the approximate region of the auriculo-ventricular septum. This area of calcification was shaped like a "C" and it moved definitely toward the apex with each systole.

Diagnosis: Calcification in the annulus fibrosus of the mitral valve; chronic myocarditis.

CASE XXIV. P.M. (X-ray No. 76195), a retired police officer, aged seventy-six, entered the Out-Door Department complaining of precordial pain and dyspnea for two years. There was no past history of rheumatism, tonsillitis or chorea but he had had severe growing pains as a child. Clinically he showed no cardiac enlargement. There was a rough systolic murmur over the precordium but no diastolic murmur. There was no precordial thrill. The rhythm was

regular. The blood pressure was 120/65. There were no evidences of failure except a slight enlargement of the liver. Roentgen examination of his heart on December 30, 1932, showed the size to be within normal limits. The measurements were: M.R., 4.8 cm.; M.L., 7.6 cm.; G.V., 5.8 cm.; Int. Dia., 31.0 cm. Roentgenoscopy showed a large C-shaped area of calcification deep in the left side of the heart, the posterior limb being only 1.5 cm. from the posterior surface of the heart. This lay just at the left border of the spine and moved toward the apex with systole. It was thought to be in the annulus fibrosus of the mitral valve.

Diagnosis: Valvular heart disease, chronic cardiac (?), mitral insufficiency; calcification in the annulus fibrosus of the mitral valve; angina pectoris.

CASE XXV. L.P. (X-ray No. 75488), a housewife, aged seventy-seven, entered the Out-Door Department complaining of weakness, backache and heart consciousness for years. There was no past history of rheumatic fever or chorea but she did remember having had severe growing pains as a child. Clinically she showed a slightly enlarged heart. There was a systolic murmur heard over the precordium loudest at the apex. There was an occasional sound heard in diastole but the heart rate was only 44, due to a normal bradycardia. The rhythm was regular. There was no thrill palpated. The blood pressure was 148/70. Slight signs of cardiac insufficiency were noted.

Roentgen examination on November 3, 1932, showed definite cardiac enlargement. There was a dense area of calcification, intracardiac in position, to the left of the midline below the medial end of the 5th cartilage located well posterior and close to the pericardium. This calcium deposit was crescentic in appearance, concave upward and moved definitely toward the apex with systole. At the time this was considered to be pericardial calcification. Further studies, however, showed that the calcification was in the heart substance, at one point only 1.5 cm. from the posterior surface of the pericardium. It was finally decided that the calcification was probably in the annulus fibrosus of the mitral valve.

Diagnosis: Calcification of the annulus fibrosus of the mitral valve; chronic myocarditis; generalized severe arteriosclerosis.

SUMMARY

A brief historical survey is presented covering the previously reported cases of aortic and mitral valvular disease with calcifica-

tion demonstrable by roentgen examination.

Twelve cases of aortic stenosis with calcification are reported, ten of which were demonstrated roentgenographically in vivo.

Thirteen cases of mitral disease with calcification are reported, all of which were demonstrated roentgenographically in vivo.

The clinical aspects of these cases are discussed.

The existing views on the etiology and pathology of calcified valves are given briefly, reviewing the literature.

The technique of roentgenoscopy and roentgenographic methods for demonstrating these calcified valves are presented.

The case histories are briefly summarized.

CONCLUSIONS

1. The roentgen-ray visualization roentgenoscopically and roentgenographically of calcified heart valves during life is possible with present-day roentgen apparatus.

2. Aortic stenosis with calcification is a common finding in older patients. Calcification in the mitral valve leaflets is accompanied by definite signs of mitral stenosis. Calcification in the annulus fibrosus of the mitral valve, at least, may be entirely unrelated to disease of the cusps and produce no cardiac symptoms.

Addenda 1. Since this article was written a case report of a calcified mitral valve in a boy, aged fourteen, has appeared in *Radiography and Clinical Photography*, July, 1933, 9, 10, by Paul A. Bishop.

2. At the present date (July 25, 1933) we have in our records 39 cases of calcification in the valves of the heart, including the 23 cases reported in this article. Of these there are 19 in the mitral valve or mitral annulus fibrosus, and 20 in the aortic valve, all demonstrated roentgenographically in vivo.

REFERENCES

1. BOYD, W. Textbook of Pathology. Lea and Febiger, Philadelphia, 1932, pp. 339-348.
2. CABOT, R. C. Facts on the Heart. W. B. Saunders Co., Philadelphia, 1926, pp. 205-766.
3. CABOT, R. C. Case Records of the Massachusetts General Hospital, Case 18171. *N. England M. J.*, 1932, 206, 906.
4. CHRISTIAN, H. A. Aortic stenosis with calcification of the cusps. *J. Am. M. Ass.*, 1931, 97, 158-161.
5. CHRISTIAN, H. A. Aortic stenosis with calcification. *Internat. Clin.*, 1931, 3, 51-54.
6. CLARK, J. H. Calcareous aortic valvular disease. *M. Clin. N. Am.*, 1931, 15, 473-480.
7. CLAWSON, B. J., BELL, E. T., and HARTZELL, T. B. Valvular diseases of the heart, with special reference to pathogenesis of old valvular defects. *Am. J. Path.*, 1926, 11, 193-234.
8. CUTLER, E. C., and SOSMAN, M. C. Calcification in the heart and pericardium. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1924, 12, 312-320.
9. DIAMOND, M. Calcification of the myocardium in a premature infant. *Arch. Path.*, 1932, 14, 137-145.
10. FLEISCHNER, F. Report on a case of calcification in the annulus fibrosus. *Wien. med. Wchnschr.*, 1925, 75, 2721.
11. GEERLING, J. C. Calcification in annular sclerosis of heart valves in arteriosclerosis. *Nederl. tijdschr. v. geneesk.*, 1929, 2, 5633.
12. KAUFMANN, E. Pathology. Translation by S. P. Reimann. P. Blakiston's Son & Co., Philadelphia, 1929, Vol. I, 41.
13. KLASON, T. Pericarditis calculosa and calcifications of the heart. *Acta radiol.*, 1921-1922, 1, 162-170.
14. MARGOLIS, H. M., ZIELLESSEN, F. O., and BARNES, A. R. Calcareous aortic valvular disease. *Am. Heart J.*, 1931, 6, 349-374.
15. MARTENS, G. The relationship between calcification of the annulus fibrosus of the mitral valves and other regressive changes. *Beitr. z. path. Anat. u. z. allg. Path.*, 1932, 90, 497-502.
16. MCPHEDRAN, F. M., and WEYL, C. N. Value of synchronization in accurate diagnosis of chest diseases. *Radiology*, 1928, 11, 458-465.
17. MÖNCKEBERG, J. G. The normal histological form and sclerosis of the aortic valves. *Virchow's Arch. f. path. Anat.*, 1904, 176, 472.
18. PARADE, G. W., and KUHLMANN, F. The roentgen picture of calcification in the heart skeleton. *München. med. Wchnschr.*, 1933, 80, 99.
19. RUDIS-JICINSKY, J. Skiagraphy as an art. *Tr. Am. Roentgen Ray Soc.*, 1903, 3, 57.
20. SAUL, W. Condensations in heart shadows. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1932, 46, 450-457.
21. SIMMONDS, M. On the proof of calcification of the heart through the roentgen process. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1908, 12, 371-373.
22. THALHIMER, W. The mechanism of the development of non-bacterial chronic cardiovascular disease. *Arch. Int. Med.*, 1922, 30, 321.
23. TUOHY, E. L., and ECKMAN, P. F. Aortic stenosis with calcareous nodules in the aortic valves. *Minnesota Med.*, 1931, 14, 289-295.
24. WELLS, H. G. Chemical Pathology. Fifth edition. W. B. Saunders Co., Philadelphia, 1925, pp. 486-496.

THE GENEALOGY OF THE ROENTGEN RAYS*

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VOLTA was a very critical and accurate experimenter. Even as a boy he had carefully built many instruments for measuring electricity. One of these was an electroscope with a straw leaf and a condenser called a "multiplier." Because of these experiments in his youth he acquired excellent experimental technique which later served him well in his important work. At first Volta was completely convinced of the correctness of Galvani's deductions, but he soon found that the source of the electricity could not be solely within the animal tissue. In one experiment he exposed a piece of nerve from a frog's leg and connected the wires without touching muscle, thus showing that an electrical effect could also be produced with one type of tissue alone. Supplementing these observations by many other experiments, he soon came to the conclusion that the source of the current was not animal electricity but originated in the metals themselves. He found in 1798 that electricity is created whenever two different conductors are placed in contact. He then replaced the term "animal electricity" by "metal electricity." These different theories of Volta and Galvani led to a sharp controversy between the two scientists which was only interrupted by Galvani's death. Going a step further, Volta divided the solid and liquid conductors into conductors of the first degree, including metal and carbon, and conductors of the second degree, or electrolytes. He measured the electrical charges with an instrument developed from the electroscope of his boyhood, the sensitivity of which he could vary within wide limits by means of a condenser arrangement. The brilliant deductions that followed Volta's experiments, especially the definition of the Volta range of potentials, are classical.

Volta's most important discovery based upon his experimental observations was the "Volta pile" (Fig. 20), which consisted of a column of alternating plates of silver and zinc or copper and zinc soldered together on one end and separated by moist cardboard or leather with which he could furnish a constant current of electricity. Volta communicated a description of this "pile" in a letter, "On the electricity excited by the mere contact of conducting substances of different kinds," dated March 20, 1800, addressed to Sir Joseph Banks, the president of the Royal Society in London. In this letter he also described the effects and the construction of the pile as well as his cup apparatus or "couronne des tasses," as he called it, which was very similar to the Volta pile. He described the construction of his battery in the following words:

"I obtain about a dozen little 20 unit plaques of discs of copper, of brass or better of silver; of a thumb's breadth, and an equal number of plaques of tin or, which is much better of zinc, of about the same shape and size. I prepare in the beginning a sufficient number of rounds of cardboard, leather, or some other spongy material capable of absorbing, holding a great deal of water, or of the moisture which is necessary for the success of the experiment.

"I place then horizontally upon a table or other base, one of the metal plates, for example, one of silver, (A = argentum) and on this first I fit a second of zinc (Z = zinc); on the second I lay one of the wet discs; then another silver plate, immediately afterward another zinc one, after that I put in sequence another wet disc. I continue so, in the same manner, coupling a plate of silver with one of zinc, and always in the same order, that is to say, always the silver below and the zinc above, or vice versa, whichever way I have begun, and interposing between each of the couples, a wet disc; I continue, I say, to build, of many of these stories, a tower as high as can stand without toppling.

* Continued from the August, 1933, issue.

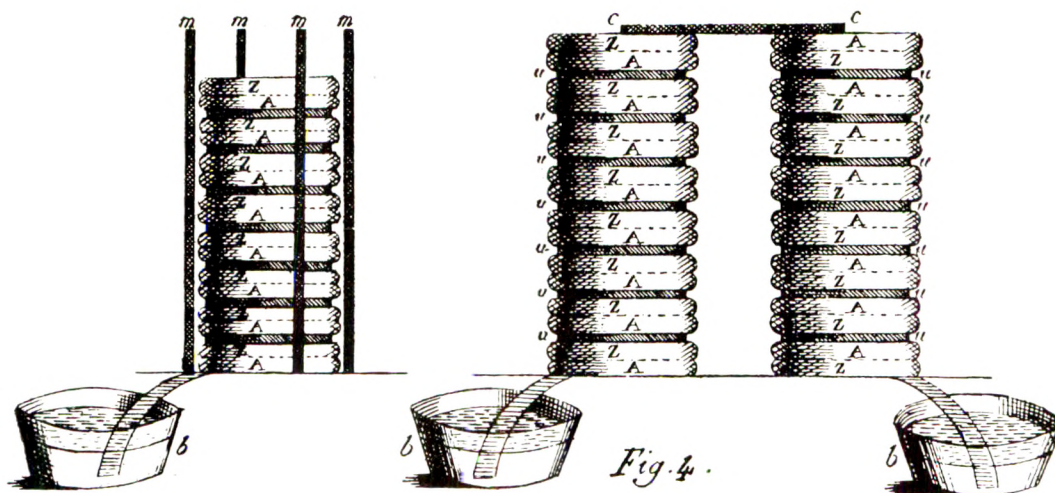


FIG. 20. Volta pile.

"Now, if it will stand up to reach about 20 of these stories of metal couples, it will already be capable, not only of making the electrometer signals of Cavallo, aided by the condenser, to as much as 10 or 15 degrees, of charging the condenser by simple touching to the point at which it will give a spark, etc., but also to shock the fingers with which one tries to touch its two ends, (the head and the foot of one such tower), with one or many little shocks, and more or less frequently, whenever one renews these contacts; every one of which resembles perfectly the slight effect given by a Leyden jar weakly charged, or a battery charged even more weakly, or finally an extremely exhausted torpedo, which imitates even better the effects of my apparatus on account of the shocks which it can give without ceasing."

From these experiments resulted the construction of the voltaic cell which revolutionized the science of physics and chemistry. The enthusiasm with which the Volta pile and the Volta cups were received may well be compared with the feverish activity which followed the discovery of the roentgen rays a hundred years later. In both cases, along with accurate observations of new and fundamental effects which were based upon the discoveries, there were many fanciful reports and wild speculations. One must remember, however, that the production of electricity by means of the Volta pile was so different from that

by means of the static machines, that there were serious doubts that both electricities were of the same nature. Another important apparatus built by Volta was the "electrophorus," an instrument with which he studied the distribution of electrostatic charges in an insulator. Professor Wilcke, mentioned previously, also seems to deserve some credit for similar studies. Volta died at the age of eighty-two, highly honored, on March 5, 1827, at his home in Como. In 1878 a monument to him was erected in Como. The original pile made by him and many of his other pieces of apparatus which had opened entirely new fields of science were collected for an exhibit in Como to celebrate the centennial of the discovery of the Volta pile; unfortunately all of this valuable collection was destroyed there in the great fire in 1889.

The fundamental experiments of Galvani and Volta soon led to the construction of new apparatus which were destined to play a most important rôle in the discovery of the roentgen rays. The greatest progress which was brought about by the discovery of the Volta pile took place in the middle of the nineteenth century. It depended upon observations made by Hans Christian Oerstedt (1777-1851) (Fig. 21), a Dane, who conducted most important experi-

ments on the interrelationship of electrical and magnetic phenomena.

Oerstedt was born on August 14, 1777, the son of an apothecary who lived in very modest circumstances in Rudkjöbing on the island of Langeland. In 1799 he obtained his Ph.D. degree after having already won several prizes at the University for his achievements. In 1806 he was appointed Associate Professor and in 1817 full Professor of Physics at the University of Copenhagen. He spent his whole life in Copenhagen, although he made frequent trips to visit his colleagues at most of the universities in Europe. He died, highly honored, at Copenhagen on March 19, 1851.

According to his own statement, Oerstedt suspected as early as 1813 that a certain correlation existed between electric and magnetic phenomena, but his famous discovery of the deviation of a magnetic needle by a conductor through which a current was flowing, was not made until many years later, on July 21, 1820. This discovery ended many a wild fantastic speculation of a number of philosophers who had reasoned for a long time that there must be some association between the Volta pile and the magnet. Oerstedt's discovery was made during a thunder storm when he placed a magnetic needle upon a table to observe its behavior under the influence of the storm. Nothing particularly interesting happened until he suddenly noticed a deviation of the magnetic needle when he accidentally connected the two ends of a Volta pile which happened to stand beside the needle, with a platinum wire. He repeated and investigated this first observation very carefully and found soon that the needle "if placed above or below the wire placed itself at right angles to it, the north pole pointing in one direction when the needle was above, and in the opposite direction when it was below. The direction of the north pole is one way or the other according to the direction that the positive electricity moves in the wire." Oerstedt communicated the results he had



FIG. 21. Hans Christian Oerstedt (1777-1851).

observed on July 21, 1820, to a number of scientific societies and to many of his friends in a letter written in Latin with the title—"Experiments on the Effect of an Electrical Conflict on the Magnetic Needle." This important communication describing the birth of electromagnetism was printed in the *Annals of Philosophy* in the same year.

The sensational discovery of Oerstedt found a brilliant interpreter in the Frenchman, André Marie Ampère (1775-1836) (Fig. 22), who presented his theories on the phenomenon observed by Oerstedt to the French Academy of Science, as early as September 18, 1820, only a short time after he had heard of Oerstedt's experiments. He stated that the Volta pile itself, as well as its outside connection, has an effect upon a magnetic needle, and that this effect proved that an electric current must flow in the pile circuit and must act upon a magnetic needle all along the circuit. He furthermore set up the rule for the direction in which this needle would point, the



FIG. 22. André Marie Ampère (1775-1836).

means of recognizing this direction and the law to determine the direction in which the current deviated the needle. Based upon his own opinion, as well as on important experiments of D. F. J. Arago and H. Davy who had observed that the connecting wire of a voltaic battery could magnetize iron, Ampère showed that electric conductors have a dynamic effect upon each other. He found that conductors in which the current flows in the same direction repel each other and those in which it flows in the opposite direction attract each other and therewith laid the further foundation for electro-dynamics. Ampère made a sharp distinction between electric current and electric tension. He called the measuring apparatus used by du Fay and Nollet and others "potential meters." "In order to measure an electric current," he said, "one must use instruments which measure the strength of the magnetic effect of these currents." He thus made for the first time a sharp distinction between electrostatics and electrodynamics.

Of almost equal importance with Ampère's theories were his experiments determining the magnetic effects of electric currents upon each other. The construction of the solenoids or the "current coil" and the basic principles of electrodynamics depend upon these experiments and they are the foundation upon which a tremendous amount of electrical technique subsequently depended. Ampère, the "father of electrodynamics," was able to arrive at his brilliant results which were "perfect in form and unassailable in accuracy," as Maxwell once said, by his extraordinary mathematical analysis combined with great experimental skill. He picked his way through complicated theories and experiments with a sure-footedness as uncanny as that of a somnambulist.

André Marie Ampère was born on January 29, 1775, in Polemieuz, near Lyon. As a child he already had shown great interest in mathematics and other scientific problems. At the age of twenty-six years he was made Professor of Mathematics in the Lyceum at Lyon. He had obtained this latter position after publishing a little pamphlet in which he showed mathematically that in gambling the chances are always against the professional gambler. Also this pamphlet probably was one reason for his being called to the Technical High School in Paris where he was elected Professor of Mathematics in 1809. There he accomplished practically all of his important work on electromagnetism. He died on June 10, 1836, at Marseilles.

Numerous investigators who followed Volta and Ampère made valuable contributions to the knowledge of electricity which cannot be discussed here. The next great strides in advancement were made by G. S. Ohm (1787-1854) a German, and Michael Faraday (1791-1867), an Englishman. George Simon Ohm (Fig. 23) came from Erlangen. His father was a locksmith but he was very much interested in mathematics and natural sciences and influenced his son to learn something of these branches of science. Ohm studied at the University

of Erlangen and obtained his degree after several interruptions. For many years he taught in high schools and finally was made Professor of Mathematics at the Polytechnic School in Nürnberg in 1833. After years of waiting and many petitions to the government, his desire to work at a large university was granted and he was made Professor of Experimental Physics at the University of Munich, in 1852. Unfortunately he did not enjoy his new position very long, for he died two years later, on July 7, 1854. Ohm's most important work was done when he was teaching at the Cologne Jesuit High School about 1825 but was incompletely described in short communications because of lack of time and poor laboratory facilities. It was not until 1827 that a complete and masterful presentation of his results was published in Berlin with the title "The Galvanic Chain Mathematically Considered." Ohm's work was formulated in the law which bears his name—"Ohm's law"—a mathematical formula stating the relationship of current,



FIG. 23. G. S. Ohm (1787-1854).



FIG. 24. Michael Faraday (1791-1867).

electromotive force, and resistance. This law states that in an electrical circuit the current is in direct proportion to the electromotive force, and inversely proportional to the resistance. His first experimental tests of the law were made with the current obtained from a Volta pile, but because of the inconstancy of this pile he later employed a thermocouple which had just been discovered by T. F. Seebeck in July, 1821. The correctness of this famous law was subsequently supported by the experiments of many prominent physicists so that the doubts existing when it first became known were soon removed.

Michael Faraday (Fig. 24) who was a contemporary of Ohm, was born on September 22, 1791, in Newington, Surrey, near London, the son of a blacksmith. In his youth he was an errand boy and an apprentice in the establishment of a bookbinder, C. Riebau in London. This occupation gave him plenty of opportunity to read books and a series of letters to his friend, Benjamin Abbot, throw considerable light

upon his self-education and his ideas at that time, when he first became intensely interested in science. In 1812, Mr. Dance, a friend, took young Faraday with him to hear four lectures on chemistry by Sir Humphrey Davy at the Royal Institution. Faraday made copious notes during the lectures and at home worked them out most carefully. When Mr. Dance saw the intense interest which Faraday took in these lectures he told him to write direct to Davy, and Faraday did so, enclosing his notes on Davy's lectures. Much to Faraday's surprise, Davy's reply was "immediate, kind and favorable";

1812

Christmas Eve.

"Sir,

I am far from displeased with the proof you have given me of your confidence, and which displays great zeal, power of memory, and attention. I am obliged to go out of town and shall not be settled in town till the end of January; I will then see you at any time you wish. It would gratify me to be of any service to you; I wish it may be in my power.

I am, Sir, your obedient servant

H. DAVY"

On March 8, 1813, Davy took Faraday into the Royal Institute as a laboratory assistant, with a weekly salary of twenty-five shillings and gave him two rooms in the institution. Faraday was able to earn Davy's confidence in a very short time so that after six months he was permitted to accompany him and Lady Davy as a scientific assistant, secretary and servant on a two-year trip through Europe. The party visited many of the famous scientific laboratories, and thus Faraday came in contact with many of the continental scientists. A few years later Faraday became a member of the Royal Society in spite of Davy's objections which were mainly based upon jealousy, or perhaps rather on the jealousy of Lady Davy. In 1820 Faraday gave his first lecture before the Royal Society; in 1829, when Davy died, he was appointed Director of the Laboratories and in 1833 he was made Fullerian Professor of Chemistry at the Royal Institution without being obliged to give lectures. He kept

this position for fifty-four years until his death on August 25, 1867, in Hampton Court near Richmond in the house given to him by Queen Victoria.

Faraday was intensely interested in Oerstedt's discovery and Ampère's fundamental deductions from it. In 1821 he repeated all of Oerstedt's experiments and wrote a historical survey of the evolution of electromagnetism up to April, 1821. In repeating the experiments, he made his first important discovery. On Christmas day, 1821, he showed his young wife his famous experiment of a magnetic needle rotating around a wire carrying an electric current. He repeated and enlarged upon the experiments of these scientists; he was especially interested in the correlation between electric and magnetic forces. He reasoned that since a magnet is influenced by an electrical current, a magnetic current must produce electric forces in conducting wires. In the fall of 1831 he made his most fruitful discoveries. On August 29, 1831, he discovered when moving a magnet inside a copper wire coil (or "making" and "breaking" the circuit in the primary of his "classical transformer") that an electrical current was flowing through the coil (Fig. 25). He had early suspected some connection between electricity and magnetism other than that described by Oerstedt and had predicted this important phenomenon which he now called "electromagnetic induction," as early as December, 1824. He commented upon his new discovery in a letter to his friend, R. Phillipps, on September 23, 1831, in the following words: "I am working again on electromagnetic problems, and I think I have something valuable, but I do not want to talk about it yet. Perhaps after all my efforts I will pull weeds instead of fish out of the water." This important principle of electricity, which, together with Oerstedt's discovery, form the basis of modern science, eventually led to the construction of the magneto-electric machine, the induction coil, the transformer, shortly to those apparatus which produce strong electric currents of

high voltage such as were used by Roentgen when he discovered the x-rays.

It is impossible to relate in detail all the brilliant experiments of Faraday which led to his discovery of electro-magnetic induction, or the many and valuable accomplishments that resulted. It must suffice to state briefly that he pointed out magnetic and electric lines of force, described magnetic induction, laid down the law of induction and the principles for production of continuous induction currents from a coil rotating between magnetic poles, the principle of earth induction, self induction, etc. He published a résumé of the knowledge of certain phenomena which had been described by many scientists and he explained how they were produced by electricity, and concluded that all of these phenomena must have come about through the same agency. In a lecture before the Royal Society he expressed this theory in the following words: "I have long held the opinion, almost amounting to conviction, in common, I believe, with many other lovers of natural knowledge, that the various forms under which the forces of matter are made manifest have one common origin; in other words, are so directly related and mutually depended, that they are convertible, as it were, to one another, and possess equivalents of power in their action."

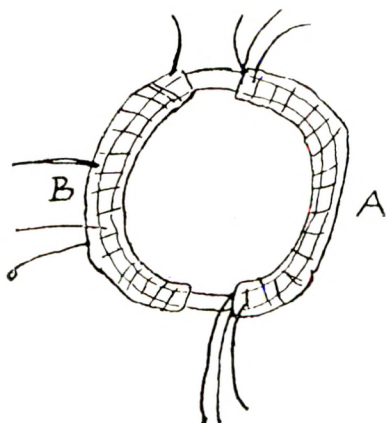


FIG. 25. Faraday's induction ring. A, primary and B, secondary windings (copy of Faraday's original drawing).



FIG. 26. Joseph Henry (1797-1878).

In 1838, Faraday started his investigations on high tension discharges through rarefied gases, which had been neglected ever since Abbé Nollet's experiments. The renewed interest in these experiments was due to the development of a glass vacuum tube which had platinum electrodes fused into the tube. They were the creation of Heinrich Geissler, a young glassblower of Bonn. Faraday studied the peculiar discharges in tubes which contained small amounts of rare earth. His name became associated with the dark space which surrounds the negative electrode, the size of which depends upon many factors, such as vacuum, potential differences at electrodes, etc. He also investigated the question as to whether or not the ether oscillations propagated from the electrode are of a corpuscular nature.

A contemporary of Faraday who made important experiments along the same lines, was the American, Henry. Joseph Henry (Fig. 26) was born in Albany, N. Y., on December 17, 1797, the son of a day

laborer. In his early youth he attended the public school and after school worked as a helper in the village store. He then entered Albany Academy, paying his own expenses from money earned by tutoring. In 1826 he accepted the offer to be Professor of Mathematics and Natural Philosophy at the Albany Academy, and six years later he was offered the Chair of Natural Philosophy at the College of New Jersey (now Princeton). During his professorship at Albany he worked on the principles of electro-magnetic current, and on an electro-magnetic motor. He made an electro-magnet capable of sustaining fifty times its own weight. After the establishment of the Smithsonian Institute in Washington in 1846, Henry was chosen as its first secretary and director. He developed the principle of the first electro-magnetic telegraph and of the dynamo and finally made a thorough study of producing induced currents. Henry's investigations were deepened and widened during his Princeton and Washington years. In 1868 Henry was elected President of the National Academy of Sciences and he held this office until his death. He died in May, 1878, in Washington, highly honored by his country. Henry's delayed publications were responsible for the fact that he does not share equal fame with Faraday, though in some of the important discoveries he undoubtedly takes precedence over Faraday. The Italian priest F. Zantedeschi who made similar experiments at the same time shared this fate with Henry. When Henry heard in 1832 of Faraday's fundamental experiments he wrote the following:

"Before having any knowledge of the method given in Faraday's account, I had succeeded in producing electrical effects in the following manner, which differs from that employed by Mr. Faraday, and which appears to me to develop some new and interesting facts. A piece of copper wire about thirty feet long and covered with elastic varnish, was closely coiled around the middle of the soft iron armature of the galvanic magnet. The armature thus formed with wire was placed in its proper position

across the ends of the galvanic magnet, and there fastened so that no motion could take place. The two projecting ends of the helix were dipped into cups of mercury and there connected to a distant galvanometer by means of two copper wires, each about forty feet long. This arrangement being completed, I stationed myself near the galvanometer and directed an assistant at a given word to immerse suddenly in a vessel of dilute acid the galvanic battery attached to the magnet. At the instant of immersion the north end of the needle was deflected 30° to the west, indicating a current of electricity from the helix surrounding the armature."

Some of Faraday's observations on electro-magnetics were enlarged upon by the German, Professor Wilhelm Weber (1804-1890), and by the Roumanian, H. F. E. Lenz (1804-1865), a member of the St. Petersburg Academy of Sciences. Weber determined the absolute measure of electromagnetic force which was one of the most important consequences of Faraday's work because it furnished the basis for exact quantitative measurement of electro-magnetism. Lenz, after repeating Faraday's principal experiments, elaborated upon them considerably and among other investigations studied quantitatively the relation between electromagnetic induction and the mechanical action of electric currents by means of a sensitive galvanometer.

In this connection mention must be made of the improvements which were made in electrostatic machines or the so-called "influence machines." G. Belli built in 1831 a new machine which had a much greater output than the type constructed by von Guericke in 1663. The first design for an "influence machine" seems to have emanated from the principle of the "electrophorus" and is probably due to Abraham Bennet who already has been mentioned as the inventor of the improved gold leaf electroscope. Other scientists improved upon this design. The more modern type of influence machine used today was introduced during the sixties of the last century, and is based upon the ideas of the Englishman, G. F. Varley and the Germans, Au-

gust Toepler (1836–1912) and W. T. B. Holtz (1836–1913). The apparatus was improved by James Wimshurst whose name is still borne by present machines. Wimshurst's patent of his static machine (Brit. Pat. Spec. No. 206, 1860) remains the foundation for all later constructions. In his machine Wimshurst still used glass plates with tinfoil while Holtz in 1880 changed to hard rubber plates following a suggestion by R. Voss, a Berlin mechanic. It is well known that after the discovery of the roentgen rays these static machines were frequently used to produce the high potential for the x-ray tube.

The construction of the instruments to measure potential and current also underwent considerable improvement. R. Kohlrausch (1809–1858) used a swinging wire suspended on a thin glass thread and studied electrostatic deflections with this instrument. The quadrant electrometer which was a great improvement on this type of instrument was designed by the English



FIG. 28. James Clerk Maxwell (1831–1879).

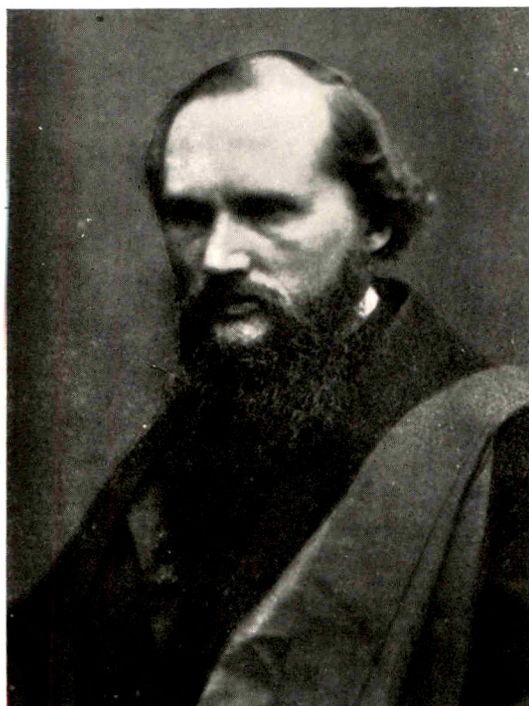


FIG. 27. Lord Kelvin (William Thomson) (1824–1907).

physicist, William Thomson (Fig. 27) (1824–1907), who later became Lord Kelvin. Kelvin had made a detailed study of the various types of electrometers in use at this time.

The electrical foundation for the important investigations to come were thus pretty well developed. Faraday's work had given the basis for the construction of high tension transformers; electrostatic machines for the same purpose were developed. The progress made at that time in the construction of vacuum tubes should also be noted. It was through Faraday's experiments that a new interest was awakened in the study of electrical discharges from evacuated tubes. In 1843, a Frenchman, Abria, observed the striated effect in vacuum tubes and studied the influence of polarity. Grove, Quet and Sequin continued the investigations in the following years (1852–1858), and another Frenchman, J. P. Gassiot, contributed many important observations on evacuated tubes. He found that the potential from a battery of over 3,500 cells

would produce the same phenomenon in an evacuated tube as that created by an induction coil.

These coils were built upon the electro-induction principle. The first induction coils were built by W. Sturgeon, in 1836, and by C. G. Page, in 1838. C. E. Neeff, J. P. Wagner and J. W. Gauley improved the apparatus by adding the mechanical interrupter and in 1853, H. L. Fizeau added a condenser. The best induction coils of that time were constructed by the Parisian mechanic, H. D. Ruhmkorff, and most of the coils constructed afterwards carried his name.



FIG. 29. Heinrich Rudolf Hertz (1857-1894).

The study of electric discharges was retarded because of inefficient methods in the production of vacuum tubes, until 1865 when Herman Sprengel developed the mercury air pump with which a relatively high vacuum could be produced very rapidly, and thereafter better tubes resulted.

In addition to these technical inferences drawn from Faraday's brilliant experi-

ments, the important theoretical conclusions made by James Clerk Maxwell (1831-1879), a Scotchman, Professor of Experimental Physics in the University of Cambridge, must be mentioned. Maxwell (Fig. 28) who was graduated at Cambridge in 1854 when Faraday was sixty-three years old, became deeply interested in the theoretical significance of Faraday's observation of electrical and magnetic fluxes and successfully translated Faraday's work into the language of mathematics. He reported his work in the book "A Dynamical Theory of the Electromagnetic Field" (1863), but his greatest work, the well-known Maxwell differential equations of the electromagnetic field, was first communicated in another paper called, "A Treatise on Electricity and Magnetism" (1873). This work was based on Faraday's conception that electrical and magnetic actions are due to a certain state of the medium between the bodies. Maxwell's further development of this idea finally led to the electromagnetic theory of light. He contended that any change of an electric field results in an electric current with which magnetic effects are associated. Furthermore he deduced that regular oscillations of electric state travel from any source of rapid and regular changes of electric discharge with the velocity of light and with the same frequency. Maxwell's creative theory and his prediction of these propagated alternations were not experimentally substantiated until after his death twenty years later by the experiments of Heinrich Hertz, a German physicist. Maxwell died at the early age of forty-eight, on November 5, 1879.

Hertz constructed a receiving resonator with which he was able to detect oscillations from a specially constructed spark gap—the Hertzian oscillator—through the air anywhere in his laboratory. He saw that the receiving oscillator had the same frequency as that of the sender. He showed furthermore that these electric waves could be reflected on a denser material than air, thus furnishing more proof of Maxwell's theories of the propagation of electrical

and magnetic fluxes. Hertz performed these important experiments on electrical oscillations at the Karlsruhe Technical High School between 1885 and 1889.

Heinrich Rudolf Hertz (Fig. 29) was born on February 22, 1857, at Hamburg. He first studied technical sciences and then physics under C. R. Kirchhoff and H. von Helmholtz, in Munich, Berlin and Bonn, and went to Kiel in 1883. He taught physics at the Technical High School in Karlsruhe from 1885 to 1889 and returned to Bonn in 1889 as the successor of Clausius. Here he was principally occupied with investigations of the electric discharge from evacuated tubes. He died from sepsis at the early age of thirty-seven, on January 1, 1894. He was one of the most brilliant physicists that ever lived. A few days before his death he wrote to his parents: "If something should really happen to me, you should not be sad, but just a little bit proud, and feel that I belong to the selected few who have lived a short life but a full one." Hertz crowded many tremendously



FIG. 31. Julius Plücker (1801-1868).

important achievements into his few years of life and he laid a most important foundation for subsequent progress in our knowledge of natural sciences. Perhaps the value of his work was characterized best by his famous teacher, von Helmholtz, in answering a letter of inquiry from the University of Bonn when this university sought a successor for Hertz. He wrote, "In looking for a successor for Hertz, it seems quite impossible to find somebody who is able to replace this unique man."

The researches of Hertz on the electric discharge in rarefied gases continued the experiments of his predecessors and were made possible by the development of the Geissler tubes. H. Geissler (1815-1879) (Fig. 30) was a modest glassblower at the University of Bonn who was given the honorary degree of Ph. D. in 1868 by the University of Bonn in recognition of his valuable assistance in many physical researches. Among other things he found that when his tubes were filled with different gases at a pressure of one to two



FIG. 30. H. Geissler (1815-1879).



FIG. 32. Wilhelm Hittorf (1824-1914).

millimeters of mercury they displayed wonderful color effects. Julius Plücker (1801-1868) (Fig. 31) the Professor of Mathematics and Physics, at the University of Bonn, gave Geissler great encouragement in his work. Plücker was more a theorist than an experimental physicist and needed skillful collaborators to carry out his ideas. Plücker and Geissler investigated the spectrum obtained from various gases enclosed in the Geissler tubes. Plücker was the first to observe the green glass fluorescence in the tubes opposite one of the electrodes and together with his student, Hittorf, he studied the influence of a magnet upon the radiations emanating from the cathode.

Wilhelm Hittorf (1824-1914) (Fig. 32) came from the family of a merchant in Bonn and obtained his Ph.D. at the age of twenty-eight, at the University of Bonn. A year later he was made "Privatdozent" at the University of Bonn but soon went to the Academy of Münster as Dozent for Physics and Chemistry. Conditions at this Academy at that time were rather bad and

he was furnished with only a small auditorium and a meagerly equipped laboratory which was not heated. His budget was 50 taler a year and his yearly salary was 300 taler. In spite of these adverse conditions, Hittorf began his researches, gave many lectures, and gradually enlarged his laboratory. He was appointed Associate Professor in 1852 with a salary of 450 taler, and in 1856, he was made full Professor of Physics and Chemistry after he had declined to accept the Chair of Physics at the University of Bern. At the time of his death at Münster, on November 28, 1914, he was ninety years old and had been Professor Emeritus at the University for twenty-five years.

The value of Hittorf's accomplishments was not immediately recognized. He was one of the first to clarify some of the unknown and mysterious effects observed on the discharges of electricity through rarefied gases which had been previously noted by Abbé Nollet, Hauksbee and subsequently by many others. In his investigation of this subject Hittorf made tubes



FIG. 33. William Crookes (1832-1919).

having a much higher vacuum than those made by Geissler. He had to overcome many difficulties in making these tubes. He had only a Geissler pump in his institute and it required much strenuous manual labor to lift a vessel full of mercury; it took several days to obtain a satisfactory vacuum. One of Hittorf's most important observations was that the light from the negative electrode (the cathode) of the vacuum tube leaves the electrode in straight lines, produces heat and causes fluorescence on the glass where it impinges. In 1869 he discovered that when solid matter is brought into the path of this light, a shadow of it is cast upon the glass walls of the tube.

Plücker later found that this light could be deflected by a magnet. "The light ray acts as an unending, thin, straight, weightless, stiff current string, which remains attached when its one end touches the negative section." Hittorf's important observations on these cathode rays were described in four publications in the years 1869 to 1884 and created a great sensation. Varley, who has been mentioned previously, advanced the hypothesis that negatively electrified particles are shot out from the cathode and can be deflected from their straight path by a magnetic field. The English physicist, William Crookes (1832-1919) (Fig. 33), substituted and enlarged upon these theories, but he was of the opinion that the radiation emanating from the cathode represented a fourth state of matter, so-called "radiant matter." It remained for Crookes to show, by a series of very careful and brilliant experiments, that matter was actually emitted from the cathode, and possessed enough energy to rotate a small wheel which he placed within the tube. Crookes demonstrated his experiments to the members of the Royal Institute on August 22, 1879, in a brilliant lecture which has become classic.

W. Crookes, who was the son of a tailor, was born in London on June 17, 1832. He studied chemistry at the Royal College of Chemistry under von Hofmann. In 1851, von Hofmann made him his assistant and

in 1855 he accepted a position as chemist in a laboratory in Chester where he worked on the spectra of various substances and discovered the green line of a new element, thallium. He investigated the properties of thallium very carefully and when attempting to determine its atomic weight in vacuum he designed his "radiometer" which in turn in its further development paved the way to his famous experiments on "radiant matter." After 1856 he lived in London where he had a private laboratory in his home. In later years he devoted most of his time to chemical and physico-chemical problems. He was highly honored and was knighted in 1897. From 1913 to 1915 he was President of the Royal Society. He died April 14, 1919, in London.

Crookes' most important studies were those on the electrical discharges through rarefied gases. In contrast to Hittorf, who published his results with great modesty in somewhat inaccessible journals, and whose books were very technical and dry, Crookes was a brilliant writer, demonstrator and lecturer. He was very successful in conveying his information about the cathode rays to a great many scientists. Therefore, he was given credit often for observations that had really been made years before by Hittorf. The tubes with which x-rays were subsequently discovered were usually called Crookes tubes instead of Hittorf tubes, both before and after the discovery of the rays. "Crookes dark room" also designated a phenomenon which had been described by Hittorf many years before. The few voices calling attention to the credit which was due Hittorf in many of these investigations received little consideration. For instance, the Director of the Royal Observatory at Berlin published the following note in the "Reichsanzeiger" in 1896:

"The lively interest created through the discoveries of Professor Roentgen permits us to correct a few misunderstandings which had been given in the news of this discovery and its historical background. Some of the terms used at the present time, such as Crookes rays, Crookes tubes, etc., should not be used. Most



FIG. 34. H. von Helmholtz (1821-1894).

of the experiments published by the English physicist, Crookes, on the so-called cathode rays were carried out many years ago by Hittorf in Muenster and by Goldstein in Berlin. Crookes added only a few insignificant details and he acknowledged the priority of the German workers in the 'Chemical News' of May 30, 1879. However, in his famous lecture which was given before the British Association in August, 1879, he omitted to mention this fact again. The German translator of the latter publication did the same thing, and, therefore, an incorrect tradition of the work has been propagated." (*München. med. Wchnschr.*, 1869, 43, 68.)

Also in England a few scientists called attention to the priority of Hittorf in many of these experiments. (*Brit. J. Photography*, 1896, 43, 111.)

The fundamental researches of Hittorf and Crookes on the radiation emanating from the cathode and the theories of von Helmholtz were responsible for the success of Hertz's experiments. In *Wiedemann's Annalen*, Vol. 48, von Helmholtz (Fig. 34) had presented his theory of electro-mag-

netic dispersion which was based on Maxwell's equations, predicting the existence of electro-magnetic oscillations of very high frequencies. Von Helmholtz was able to foretell certain properties of the hitherto unknown radiation which later was discovered to be the x-ray. For example, he described the phenomena of deflection, diffraction, and penetration. The Helmholtz theory could also be applied to rays of smaller frequencies and at the time it became known was well substantiated by Hertz's brilliant experiments. Von Helmholtz really predicted theoretically Roentgen's great experimental discovery.

Hertz's important work was continued by his pupil, Philipp Lenard (Fig. 35). Lenard was born on June 7, 1862, in Pressburg, Hungary, a son of the merchant Philipp von Lenard. He studied mathematics and natural sciences in Budapest, Vienna, and Heidelberg, under von Helmholtz, Bunsen and Quincke. In 1886 he obtained his Ph. D. degree and became an assistant to Quincke in Heidelberg. In 1891

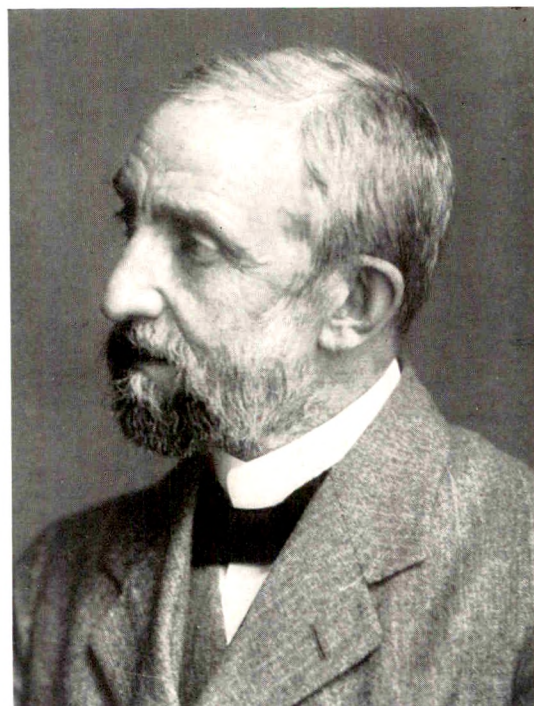


FIG. 35. Philipp Lenard (1862-).

Hertz asked him to come to Bonn as Privatdozent. After the death of his teacher, Lenard went to Breslau and then in 1895 to Aachen where he was made Dozent of Theoretical Physics. A year later he accepted the call to the Chair of Physics at the University of Heidelberg where he was also made Director of the Physical Laboratory of the University. Lenard deserves much credit for the important investigations of the property of cathode rays which made him the immediate predecessor of Roentgen. In 1892, Hertz had demonstrated (experimentally) the transmission of cathode rays through metals. He pasted thin gold, silver or aluminum foil upon the inside of a uranium glass disc and found that a fluorescence of the glass could be observed even after the cathode rays had passed through the metal foils. Lenard, discussing these fundamental experiments in his Nobel lecture said,

"One day Hertz called me into his office, an event which, much to my regret, took place very seldom, and showed me an observation which he had just made. A piece of uranium glass inside an evacuated tube was covered with aluminum foil and showed fluorescence under the foil. He told me one could separate two spaces by aluminum foil, and also asked me to continue the experiments, which he did not have time enough to do. In one space the rays could be produced as usual, but in the other space they could be observed in a purer state than ever before. However, on account of the thinness of the foil there should only be a small difference of air pressure between the two spaces. Still one of the two spaces could be well evacuated, and one could study whether or not this would affect the production of the cathode rays, that is, one could see whether or not they were phenomena produced in matter or processes within the ether."

Lenard continued Hertz's experiments by placing a thin aluminum foil (0.0026 mm. in thickness) window opposite the cathode in an evacuated tube. With a few particles of fluorescent potassium phosphate he could see that the cathode rays not only penetrated through the window but also travelled quite a distance in the

free air. This important observation was made for the first time on October 20, 1892. Hertz realized the great significance of this observation at once and expressed his opinion to von Helmholtz in a letter dated December 15, 1892:

"A very peculiar discovery was made in the last weeks by Dr. Lenard, my assistant. He closed Geissler tubes with extremely thin aluminum foil and succeeded in using foil of proper thickness to keep the vacuum but still permit an appreciable amount of the cathode rays to go through them. He has found that these rays after once being produced can be propagated through air and through various gases; this opens an entirely new field of investigation because it is now possible to completely separate the production of these rays from their observation. I advised Dr. Lenard to send a short communication to the Berlin Academy on account of the importance of his results."

The outstanding investigations by Lenard which followed upon this first discovery are well known. They provided a significant basis for the important discovery of the roentgen rays, a fact which Roentgen mentioned in his first communication by speaking of Lenard's "wonderful experiments."

Lenard noted that cathode rays are not visible but their effects can be studied with fluorescing substances such as phosphates and ketones. Apparently he did not use barium platinum cyanide at that time. He also found that the cathode radiation darkens photographic plates, an observation which had been made also by the Berlin physicist, Goldstein, in experiments in which the plate was brought inside the tube.

Lenard's cathode-ray tube (Fig. 36) with which he made his important observations, is well known. Such tubes were also among those used by Roentgen at the time of the discovery of the roentgen rays and one of them is still to be seen in the Museum of the Würzburg Physical Institute. Lenard later improved his first tubes by sealing a thin aluminum window upon a platinum cylinder which was fused into the glass.

With a fluorescent screen, Lenard showed that the air near the window of the tube acted like a cloudy medium. The rays which were propagated in straight lines within the tube were scattered in all directions outside the window; from this he reasoned that the molecules of air scattered the rays, probably just as ordinary light is scattered by fat globules in milk. He concluded that the rays must be something extraordinarily fine, and therefore he started to investigate photographically their pene-

the laws of mass proportion of the absorption of cathode rays and then to question whether the phenomena observed with the cathode rays were taking place in matter or in ether. He concluded that ether was concerned although he did not believe in ether waves. He advocated this theory against that of the English school, whose protagonists believed in a "stream of electric particles" or "electrolytic radiation." Lenard attempted to support his theory experimentally by passing the cathode rays from

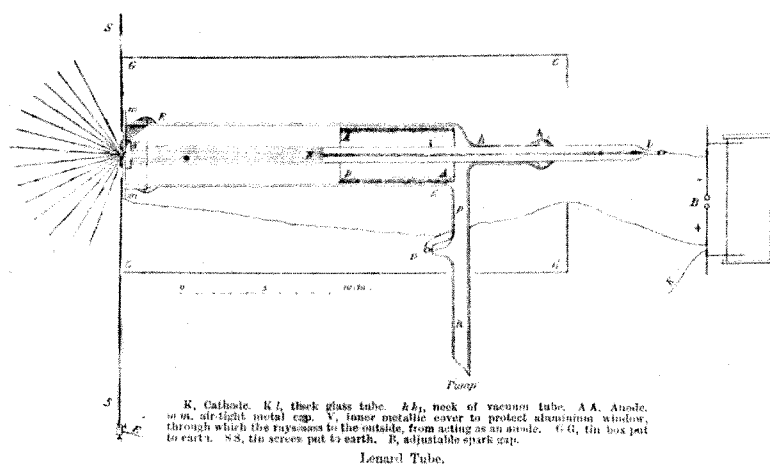


FIG. 36. Lenard's tube.

tration through solid matter. He found that the density of the absorbing material is important, but not its physical state. Gold showed the greatest absorption of the cathode rays, silver somewhat less, and aluminum still less. If equal thicknesses (0.000071 mm.) of the metals were used and if metal parts of the same weight per area (0.75 mg. per sq. mm.) were used, equal absorption was observed. In these experiments Lenard employed his familiar aluminum "ladder" which had from one to nine layers of aluminum foil, 0.0014 mm. thick, and was used successfully to analyze the penetration of various cathode-ray beams. Such metal ladders were frequently employed for absorption measurements of x-rays after Roentgen's discovery.

Lenard's experiments led him to study

one tube into another which was highly evacuated, so that the sharply defined cathode beams in this second tube could be deflected by a magnet and thus studied to better advantage than when the cathode rays were scattered in air.

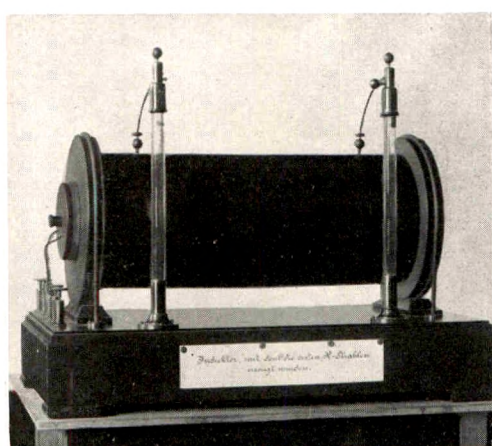
Lenard also replaced the aluminum window in his tube with a thin glass window and obtained equally satisfactory results but he personally preferred the aluminum window on account of its lightness and ease of manipulation. He also made the important observation that there were different kinds of cathode rays which were deflected to a greater or less degree by means of a magnet. This fact had also been noted by Goldstein who was the first to observe the positive channel rays and who described fluorescence in the glass wall and

also observed the phenomenon of scattering of the cathode rays. His observations that cathode rays discharge electrically charged bodies, independent of their charge, was of great importance.

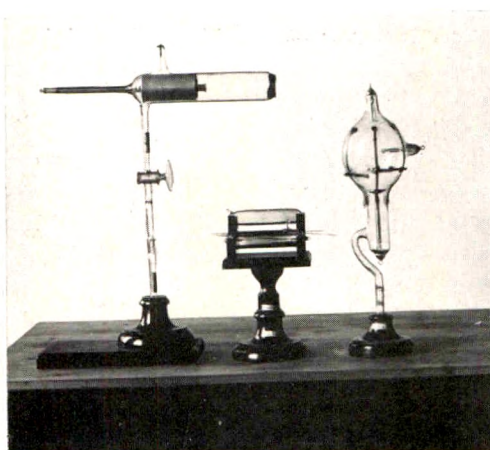
Lenard's investigations, as well as all the brilliant work done by the many other investigators of cathode rays (Elster and Geitel, Goldstein, Pulu, Lehmann, Schuster, E. Wiedemann, Warren de la Rue, W.

Spottiswood, J. J. Thompson, J. Perrin, L. Weber, A. A. de la Rive) cannot be detailed at this time.

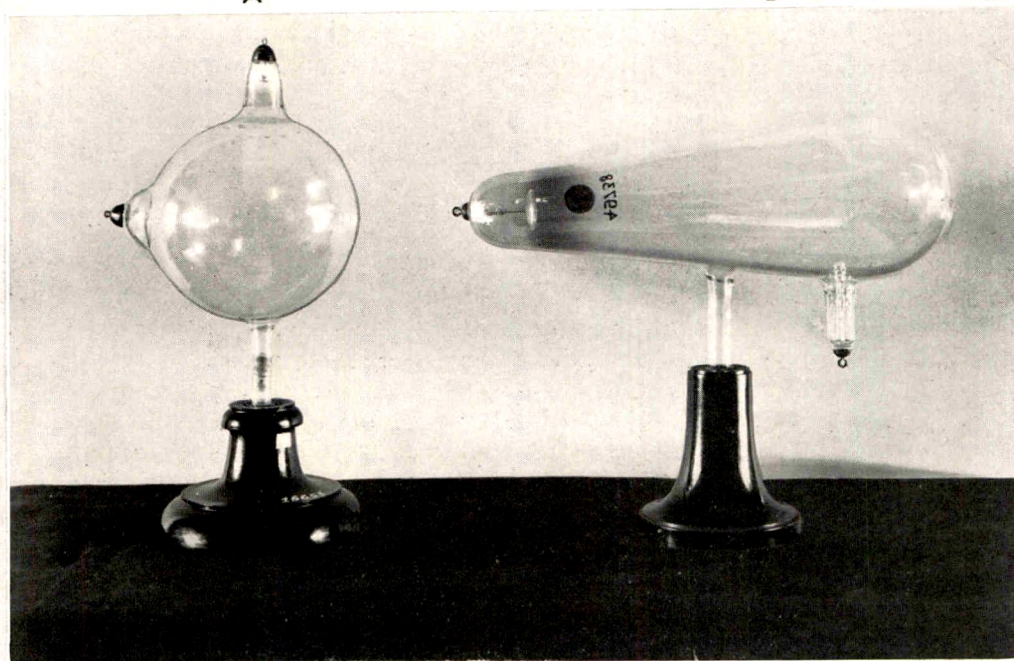
This, then, was the state of affairs in the construction of high tension apparatus and concerning the knowledge of discharges of electricity through rarefied gases when Wilhelm Conrad Roentgen started to make practical experiments on these problems in October, 1895. Soon thereafter he dis-



A



B



C

FIG. 37. Roentgen's original apparatus with which he discovered the x-rays. A. Ruhmkorff induction coil. B. Lenard tubes. C. Hittorf-Crookes tubes.



FIG. 38. Roentgen's first x-ray picture of a hand.

covered the x-rays (Fig. 37). One of the best accounts of this fundamental discovery was given by the English scientist, Sylvanus P. Thompson at a meeting of the newly founded British Roentgen Society on November 5, 1897:

"November the eighth, 1895, will ever be memorable in the history of Science. On that day a light which, so far as human observation goes, never was on land or sea, was first observed. The observer, Professor Wilhelm Conrad Röntgen. The place, the Institute of Physics in the University of Würzburg in Bavaria. What he saw with his own eye, a faint flickering greenish illumination upon a bit of cardboard, painted over with a fluorescent chemical preparation. Upon the faintly luminous surface a line of dark shadow. All this in a carefully darkened room, from which every known kind of ray had been scrupulously excluded. In that room a Crookes's tube, stimulated internally by sparks from an induction coil, but carefully covered by a shield of black cardboard, impervious to

every known kind of light, even the most intense. Yet in the darkness, expressly arranged so as to allow the eye to watch for luminous phenomena, nothing visible until the hitherto unrecognized rays, emanating from the Crookes's tube and penetrating the cardboard shield, fall upon the luminescent screen, thus revealing their existence and making darkness visible. From seeing the illumination by the invisible rays of a fluorescent screen, and the line of shadow across it, the work of tracing back that shadow to the object which caused it, and of verifying the source of the rays to be the Crookes's tube, was to the practised investigator but the work of a few minutes. The invisible rays—for they were invisible save when they fell upon the chemically painted screen—were found to have a penetrative power hitherto unimagined. They penetrated cardboard, wood and cloth with ease. They would even go through a thick plank, or a book of 2000 pages, lighting up the screen placed on the other side. But metals such as copper, iron, lead, silver and gold were less penetrable, the densest of them being practically opaque. Strangest of all, while flesh was very transparent, bones were fairly opaque. And so the



FIG. 39. Dr. W. C. Roentgen.
(Photograph made in 1894)

discoverer, interposing his hand [Fig. 38] between the source of the rays and his bit of luminescent cardboard, *saw* the bones of his living hand projected in silhouette upon the screen. The great discovery was made."

The sensational reception of this discovery throughout the civilized world is well known. It has been dealt with in detail in my book "Wilhelm Conrad Röntgen and the History of the Röntgen Rays" (Springer, Berlin, 1931. English edition, Bale, London, 1933.)

Wilhelm Conrad Röntgen (Fig. 39) was born on March 27, 1845, in Lennep, Germany, the only son of a manufacturer and cloth merchant. He studied engineering and physics in Utrecht and Zürich and was made Privatdozent of Physics at the University of Strassburg in 1875. In 1879 he was called to the Chair of Physics at the University of Giessen and in 1888 to the University of Würzburg. It was in Würzburg that he made the discovery of the x-rays in November, 1895. In April, 1900, he accepted the call of the University of

Munich and moved to the Bavarian capital by special request of the Bavarian government. In 1901 he was awarded the first Nobel prize for physics. He died, highly honored, in Munich, on February 20, 1923, at the age of seventy-eight.

Roentgen's discovery of the x-rays forms the brilliant climax to the studious application and previous accomplishments of many other scientists: Lenard, von Helmholtz, Hertz, Hittorf, Crookes, and before them, Maxwell, Faraday, Ohm and Ampère, and then Galvani, Volta and Franklin, Henry, and many others, back to von Guericke and Gilbert. They all contributed to the knowledge of the fundamental facts of electricity through the brilliant development of the production of high tension currents and the creation of highly evacuated tubes and the study of the electrical discharges through the vacuum which finally led to the important discovery of the roentgen rays.

Figures 5, 9, 12, 16, 19, 21, 22, 23, 24, 28, and 33, were drawn from old prints by Miss Mary Isom.



A BASIS FOR THE COMPARISON OF ROENTGEN RAYS GENERATED BY VOLTAGES OF DIFFERENT WAVE FORM

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ABSTRACT

Earlier studies of the relationship between the applied voltage and the emission of general roentgen radiation for various voltage wave forms (*Bur. Standards J. Research*, 1932, 9, 769 (R.P. 505)) have been extended to include generators not previously available. The roentgen-ray output per effective (r.m.s.) milliamperere of tube current is found for full wave and constant potential to be nearly the same at any given value of the effective (r.m.s.) voltage. For half-wave generators it is necessary to make allowance for suppressed half-cycle which is useless in the production of roentgen rays but which enters in the measurement of current or voltage with an a.c. meter. Current and voltage measurements with half-wave rectifiers are corrected so as to apply only during the useful portion of the cycle by the application of a factor of $\sqrt{\frac{1}{2}}$ and $\sqrt{2}$ to the corresponding values measured over a whole cycle. The half-wave generator then yields results similar to the other generators. The roentgen-ray quality, as expressed by a full absorption curve, is found to be the same for all wave forms having the same effective (r.m.s.) value, and regardless of peak values. It is thus possible to adequately express the quality of any radiation in terms of the effective voltage used to excite it. This in turn relates the quality directly to that produced by constant potential. Thus the difficulty in the use of a full absorption curve to express roentgen-ray quality—namely, its inexpressibility as a single numerical magnitude—is overcome. All output measurements made in terms of peak voltage and average current are found to be without real significance in quality determinations.

I. INTRODUCTION

ROENTGEN radiation is necessarily and adequately specified physically by its intensity (quantity) and spectral distribution (quality, hardness).

The intensity is defined as the quantity

of energy flowing through unit cross section of the beam in unit time. The spectral distribution is defined as the fractional part of the intensity comprised within a uniform narrow wave length (or frequency) interval throughout the roentgen-ray spectrum.

Intensity is ideally measured in ergs per square centimeter per second. In practice, however, intensity is commonly expressed in roentgens per unit time, which are proportional to the electrical conductivity which the roentgen-ray beam imparts to a cubic centimeter of air. This conductivity is, for any given wave length or any given spectral distribution, very closely proportional to the intensity.¹ Since, however, the factor of proportionality varies with the wave length, the ionization chamber indications do not serve to give the relative intensities of different spectral distributions. The conductivity imparted to air by radiations having different spectral distribution is probably a better measure than intensity of their relative therapeutic value; hence, the conductivity of air, expressed in roentgens per unit time, has been internationally adopted as the physical unit of measure of a roentgen-ray dose. But, even in dosage, it is important to realize that the same number of roentgens represents the same dose only when the effective spectral distribution of the radiations is the same.

The spectral distribution of intensity is represented by a curve, throughout the spectrum, plotted as a function of the wave length or the frequency. Its direct determination is cumbersome and subject to considerable error. In practice it is inferred

¹ Deviation from this proportionality occurs only for roentgen-ray beams of such great intensity that columnar ionization takes place. This is seldom encountered in practice.

as quality (or "hardness") from the thickness of an absorber, say copper, required to reduce the number of roentgens in the radiation to one-half. This thickness is called the half-value layer.² More complete information of the spectral distribution is inferred from the complete absorption curve³ obtained with a series of thicknesses of the absorbing material.^{4,5,6} In fact, Silberstein⁷ has shown that the complete effective spectral distribution curve neglecting characteristic lines is obtainable from an exact absorption curve.

It is well known that the half-value layer falls short of satisfactorily expressing the quality of the radiation; and the complete absorption curve, though adequate, lacks the very desirable simplicity of being expressible as a numerical magnitude. The experimental results published in previous papers^{8,9,10} and those to be presented here show, however, that the radiation emitted by a given tube supplied by a generator of any voltage wave form has a quality (full absorption curve) nearly identical with that which could be obtained with some constant potential generator operating at a particular voltage. Furthermore, it is found that with different generators operating to give the same quality, the intensity is more nearly proportional to the effective tube current than to the average tube current.

A roentgen-ray tube, on a given constant voltage, emits a radiation of definite spectral distribution which is independent of the tube current; as the current increases, the radiation increases alike for all wave

lengths. The ionization chamber measures the number of roentgens per unit time which, in this case, are proportional to the intensity. As the applied voltage is increased, a larger fraction of the intensity of the roentgen-ray beam falls in the higher frequency—shorter wavelength—intervals. The intensity has increased more than the number of roentgens per unit time as measured by the ionization chamber; and the number of roentgens measured has increased more than the dosage of the radiation. Similarly, when a pulsating voltage wave form is used to excite the tube, the quality of the radiation fluctuates during the cycle from the softer initial value of the harder crest value during the wave period; and adds up to some average spectral distribution which the operator seeks to characterize in some definite and simple way. Experiment shows this composite spectral distribution, for the common types of roentgen-ray generator, to be equivalent to that produced by the particular constant potential which produces a radiation having also the same absorption curve. Comparing mechanical rectifiers (full wave) with a constant potential excitation, 150 kv. constant potential caused a radiation having the same absorption curve as produced by 190 kv. (peak) and by 200 kv. (peak) respectively, on two mechanical rectifiers; and this similarity extends over widely different values of the peak voltages. It was also found that these two mechanical rectifiers were, in fact, operated at 150 kv. effective (r.m.s.).¹¹ Furthermore, for any other given value of the effective voltage, the absorption curves for all three generators were found closely alike for filtrations up to 1.2 mm. of copper.

In addition, for the same effective voltage, the intensity of the radiation, as measured by air ionization, per effective milliamperes of tube current was practically the same for the different types of generator, even when the load distorted the voltage wave form. Having established by the resultant absorption curve that the quality

² Taylor, L. S. *Bur. Standards J. Research*, 1930, 5, 517 (R.P. 212).

³ This is commonly given by plotting the logarithm of the per cent of radiation transmitted, as indicated by the ionization chamber, against the thickness of the absorbing medium.

⁴ Pohle, E. A., and Wright, C. S. Limit exposure in radiography; supplementary report. *Radiology*, 1930, 14, 17-23.

⁵ Taylor, L. S. Absorption measurements of x-ray general radiation. *Radiology*, 1931, 16, 302-321.

⁶ Wilsey, R. B. On specification of x-ray quality. *Radiology*, 1931, 17, 700-713.

⁷ Silberstein, L. *Phil. Mag. Ser. 7*, 1933, 15, 375.

⁸ Taylor, L. S., and Tucker, K. L. *Bur. Standards J. Research*, 1932, 2, 333 (R.P. 475).

⁹ Taylor, L. S., Singer, G., and Stoneburner, C. F. *Bur. Standards J. Research*, 1932, 2, 561 (R.P. 491).

¹⁰ Taylor, L. S. *Strahlentherapie* (in press).

¹¹ See footnote No. 9.

of the radiation from different types of generator is the same when the effective voltage is the same, it is sufficient, for comparing heterogeneous roentgen-ray beams or roentgen-ray generators to measure the radiation intensity at one filtration only and at different effective voltages. That is, two generators yielding the same output per milliamper, at a given filtration and given effective voltage, will function closely alike at other effective voltages and filtrations. This was found to hold with the types of generators used, for filtrations ranging from 0.1 to 1.2 mm. copper. It should be added that, for the same effective voltage, the output per effective milliamper of the tube is alike not only as regards air ionization and absorption curve, but also was found alike as regards percentage depth intensity in media of low atomic number.

The need felt for specifying the quality of the radiation by a single magnitude is thus satisfied by stating the constant voltage which will produce it; and, in addition, the intensity of the radiation having that quality is given as more nearly proportional to the effective than to the average tube current. In fact, it was found that the output per average milliamper varied with peak voltage to such an extent as to be without real significance in most cases. This fact is undoubtedly responsible, in a large measure, for the very great discrepancies between comparisons of roentgen-ray tubes and generators by various observers, many of whom have been prone to compare generators or tubes under widely different load conditions, then correcting the various outputs on the assumption that there is a linear relationship between roentgen-ray output and average tube current. For the usual roentgen-ray transformer having characteristically large electrical regulation, this assumption is far from correct.

Another common error has been introduced by improper control of such factors as the capacitance of the aerial system, diaphragming of the roentgen-ray beam, and the type of tube inclosure. Tests made in connection with this and past studies

have shown that a variation of any one of these factors influences the final result and it is thus essential that all such factors remain constant throughout any adequate comparison of roentgen-ray tubes or generators.¹²

As a continuation of the study outlined in the foregoing paragraphs, the main objects of the present paper are:

(1) To compare the radiation from a single roentgen-ray tube operated on several types of voltage wave form;

(2) To compare the effect of different criteria of control of applied voltage and tube current;

(3) To show how various radiations may be equated to constant potential radiation.

II. EXPERIMENTAL PROCEDURE

The following types of high voltage roentgen-ray generator were employed: A double disc mechanical rectifier, *B*,¹³ having a divided high tension transformer (two transformers in a single tank) and rectifying over approximately 20 degrees of the half cycle; a commercial "constant potential" generator, *C*, having a ripple¹⁴ of about 2 per cent per milliamper; a "constant potential" generator, *F*, (B.S. Standard) having a ripple of about 0.2 per cent per milliamper; a half-wave kenotron rectifier, *D*, using the same two-pole high tension transformer previously used for generator, *A*; a full-wave kenotron rectifier, *E*; and a half-wave kenotron rectifier, *G*; using the same high tension transformer as generator *E*.

A single type of thin-walled cerium glass

¹² See footnote No. 8.

¹³ The letter designations of generators *A*, *B*, and *C* correspond to those used in earlier publications involving the same generators under the same condition of aerial, tube enclosure, etc. Hence the results given here are for the most part directly comparable with those given in the papers cited earlier.

¹⁴ Up to the present the term "constant potential" has been used in describing the potential supplied by kenotron or other valve tube rectification in which there is, of course, a slight ripple. A more accurate designation of voltages not actually constant but fluctuating about some mean value is "ripple voltage." Thus by a "ripple quantity" (potential or current) is meant a periodic quantity $y = V_0 + V_1 \sin(\omega x + \alpha_1) + V_2 \sin(2\omega x + \alpha_2) + \dots$ in which the constant term V_0 is so large that all values of the quantity are positive (or negative). The amount of ripple ("ripple" or "ripple") in a ripple quantity is the ratio to the average value of the difference between the maximum and minimum values of the quantity.

Coolidge tube was used throughout this study.

All generators were so arranged that they could be connected to the same aerial system leading to the roentgen-ray tube (Fig. 1). An interchange of generators could be accomplished in a minute's time

Littel fuses. In addition, the meter and fuses were short-circuited when not actually being read.

Average and effective (r.m.s.) tube voltages were measured respectively with d.c. and a.c. voltmeters used in conjunction with a 150-megohm non-inductive shielded

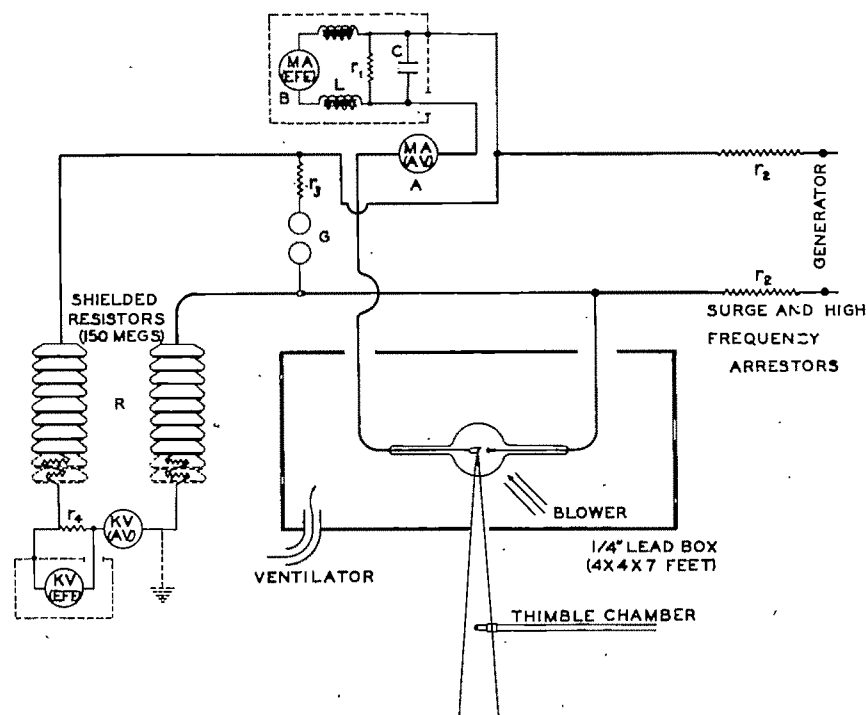


Fig. 1. Diagram of apparatus showing voltage and current measuring equipment.

so as to eliminate any short-time changes that might occur in the tube. Numerous check runs made at intervals over several months showed no change in the roentgen-ray tube used. An air blast from a high pressure blower was directed against the tube walls for cooling. Half-megohm surge resistors were used at all times in each side of the high tension line for suppressing any surges or high frequency oscillations.

Average and effective (r.m.s.) tube currents were measured in the manner previously described.¹⁵ For the effective current measurements a thermo-milliammeter, *B*, was used. To protect the heating element from damage due to surges it was connected into the circuit through 1/32 amp.

¹⁵ See footnote No. 9.

resistor, *R*,¹⁶ placed across the high tension leads to the tube. The meters were connected in the center of the resistance so as to be near ground potential. This voltage measuring unit never drew more than 1 milliamperes from the circuit and hence had no undesirable effect on the operation of the generators.

The tube output was measured in roentgens per minute by means of a calibrated thimble ionization chamber kept in a fixed position with respect to the filters and tubes. The distance from the center of the chamber to the center of the focal spot was 50 cm., and at 15 cm. from the chamber were placed the limiting aperture and a

¹⁶ Taylor, L. S. Bur, *Standards of Research*, 1930, 5, 609 (R. P. 217).

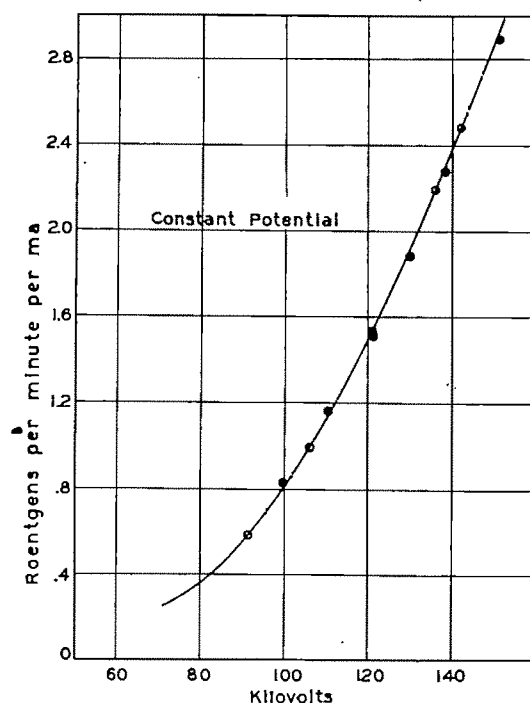


FIG. 2. Roentgen-ray output as a function of applied "constant potential" for 1 per cent and 10 per cent ripple.

permanent filter (except during the determination of absorption curves) of 0.557 mm. of copper, plus 1 mm. of aluminum¹⁷ on the side next to the chamber. Earlier tests showed that secondary radiation from the filter at this distance had no influence on the ionization measurements. The diameter of the beam at the chamber was 5.5 cm. throughout. To show the effect of the cross sectional area of the beam upon the measurements, it was found that when a beam diameter of 14.5 cm. was used there was an increase in ionization of 9.0 per cent for all voltages applied to the tube. This increase may be ascribed to the inclusion of stem radiation which had been cut off by the smaller aperture. In order that measurements made at different times might be directly comparable, all ionization current readings were corrected to a normal atmospheric condition of 22°C. and 76 cm. mercury pressure.

¹⁷ Compare with 0.535 mm. Cu filtration used in our earlier papers.

III. EXPERIMENTAL RESULTS

(a) Output per average milliampere.

Outputs per unit tube current were usually determined from two operating currents, 4 and 6 ma., to bring out the differences produced by changes in the tube load. Similar measurements made for smaller and larger tube currents show that the order of magnitude of the change in output per average milliampere with tube current is about the same at all currents up to 10 ma.

Figure 2 shows, for the two constant potential generators, *C* (dots) and *F* (circles), the output per average milliampere as a function of the peak voltage. The ripple of these generators was about 10 per cent and 1 per cent, respectively, at the tube currents used. It will be noted, however, that the points for the two generators fall very closely along the same curve. This bears out previous findings that, for the type of measurement encountered in

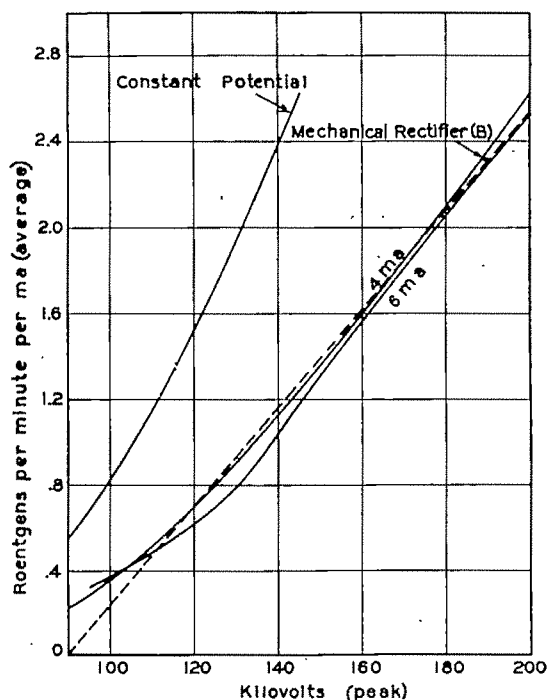


FIG. 3. Output per average milliampere as a function of the peak voltage for a mechanical rectifier. (To avoid confusion the actual data points are not plotted on this and most subsequent figures.)

therapeutic roentgen-ray work, the difference in roentgen-ray output between 1 and 10 per cent ripple in constant potential generators is not greater than 1 or 2 per cent and is consequently of no significance.

The average and effective tube currents in Figure 2 were almost identical, as of course they should be. The peak voltages measured with a sphere gap were higher than the effective or average voltages by about the expected amount. This accounts for the 10 per cent ripple in generator *C* as against 1 per cent in *F*. For closest agreement between the two generators, *F* and *C*, effective rather than peak voltages should of course be used, although the difference is seen to be small enough to be neglected for many purposes.

The output per average milliampere for the mechanical rectifier, *B*, is given by the curves in Figure 3 as a function of the peak voltage. Similar curves for the half-wave generator, *D*, are given by curves in Figure 4; and for the full-wave, *E*, and half-wave, *G*, generator by curves in Figure 5.

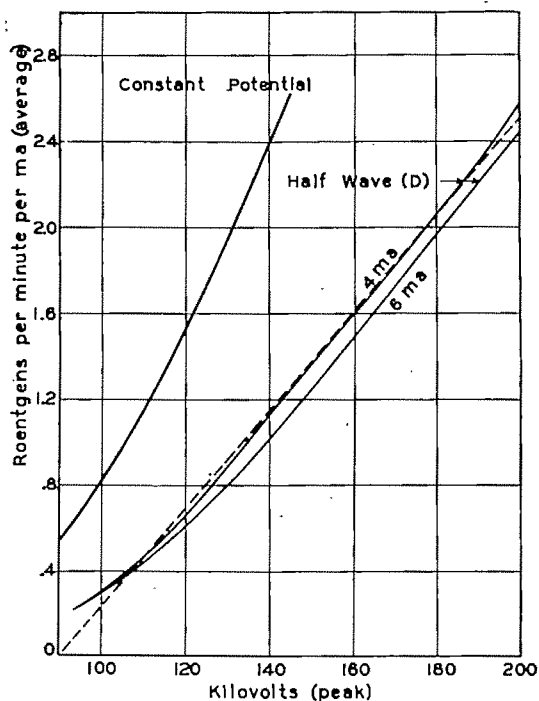


FIG. 4. Output per average milliampere as a function of the peak voltage of a half-wave valve tube rectifier.

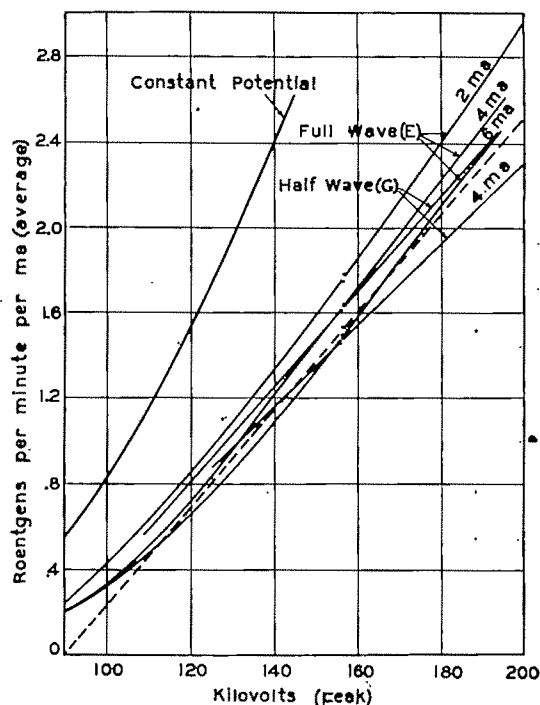


FIG. 5. Output per average milliampere as a function of the peak voltage for a half-wave and full-wave valve tube rectifier, using the same high tension transformer.

Curve *C* on each plot is for constant potential. The straight-dashed line is the same on all curves and is purely for reference to assist in comparing curves between different groups.

The first fact of significance is the same as reported by us in similar earlier studies,¹⁸ namely, the very great difference between the output per average milliampere for constant potential as compared with all other wave forms.

For generators *B*, *D*, *E*, and *G*, the outputs per average milliampere are grouped within a comparatively narrow region. However, as the voltage increases the divergences between the several generators seem to be increasing, as well as the divergences between the outputs of the same generator under different loads. In fact, at 200 kv. (peak) there is, based upon this type of comparison, an output spread of about 25 per cent between the several generators.

¹⁸ See footnote No. 8.

The variations between generators are in part due to differences in electrical regulation of the main transformer. Hence, to compare the half-wave and full-wave generators, the same transformer should be used. This was done with generator *E* for which the output curves are given in Fig-

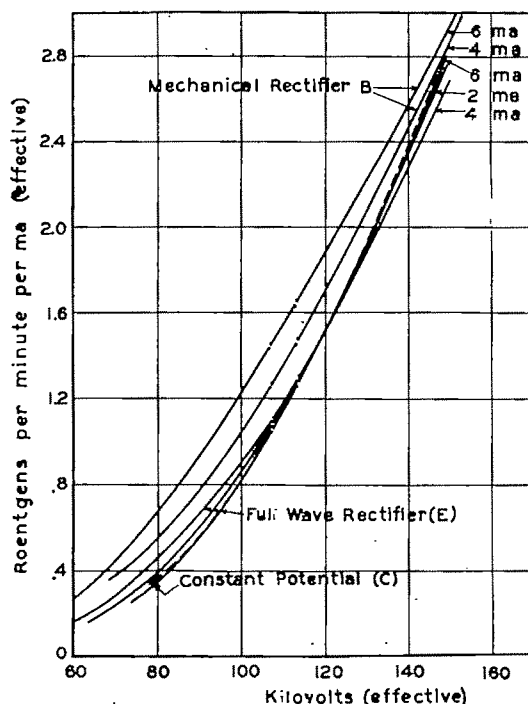


FIG. 6. Output per effective milliampere as a function of the effective voltage for a mechanical rectifier and full-wave valve tube rectifier.

ure 5. The results, which have been thoroughly checked, are not consistent with respect to load conditions. At 4 ma. (average) tube current there is an increasing divergence between the half- and full-wave generators, beginning at 1 per cent at 130 kv. (peak) and reaching 17 per cent at 190 kv. (peak). At 6 ma. there is a decreasing divergence in going to higher voltages, changing from 17 per cent at 130 kv. (peak) to 1 per cent at 190 kv. (peak). The impossibility of accurately comparing roentgen-ray generator outputs on the basis of average tube currents and peak voltages is confirmed.

There is thus no obvious relationship between the roentgen-ray outputs even when

operated on the same transformer and accordingly in comparisons it is not strictly necessary to use identical transformers.

The only generalization that can be made from these data is that, if the tube currents are not varied over a range greater than ± 2 ma. (av.), the outputs of the various generator types will be the same within ± 15 per cent. It is, moreover, found that the output per average milliampere depends upon the particular tube current to such a degree as to render meaningless all comparisons between tubes and generators unless carried out at the same average current.

Many observers have been prone to compare generators or tubes under widely different load conditions, correcting the various outputs on the assumption that there is a linear relationship between roentgen-ray output and average tube current. For the usual roentgen-ray transformer, having characteristically poor electrical regulation, this assumption is far from correct. For example, it is not permissible to assume that, if the outputs of two generators at a given peak voltage differ by 20 per cent, the difference can be made up by increasing the tube current of one by 20 per cent, keeping the same peak voltage.

The observed difference in output per average milliampere between the half- and full-wave generator should ideally be nil, since to obtain the same average tube current with a half-wave generator as for a full-wave generator, over a number of cycles, the current during a single half-cycle need only be doubled throughout. However, in practice a marked difference is observed principally because of the large electrical regulation of the transformers. For, with the necessarily larger instantaneous values of the tube current in the half-wave generator, the resultant voltage waveform becomes so distorted as to produce a marked influence upon the roentgen-ray output. Furthermore, some roentgen tubes are purposely constructed by such a disposition of the focusing shield as to limit the space charge effect and so as to pass

only a narrow current wave. With such a tube the difference between a full- and half-wave generator is more marked.

(b) *Output per effective milliampere.*

Effective (r.m.s.) tube currents and voltages were obtained at the same time as the data just presented, hence are entirely comparable therewith. Values of the roentgen-ray output per effective milliampere, as a function of the applied effective voltage, are plotted in Figure 6 for generators *B*, *C*, and *E*. The broken line curve, *C*, is for constant potential. It is seen that, as with the earlier reports, the curves for the full-wave generator, *E*, follow very closely along the curve for constant potential, while those for the mechanical rectifier, *B*, approach the constant potential curve at higher voltages. At 150 kv. (effective) the total spread of the output per effective milliampere for all three generators is less than 10 per cent, while, for either *B* or *E* alone, with constant potential, it is less than 4 per cent.

It is thus indicated that the output per effective milliampere at the higher voltages is approximately the same for full-wave generators and constant potential. The previous studies show that the roentgen-ray quality for given effective voltages would likewise be the same.

Measurements of the effective (r.m.s.) voltage in half-wave generators have little significance except under ideal conditions which seldom exist in roentgen-ray circuits. This is because the effective voltage meter gives a root-mean-square value over a whole cycle, while only half the cycle is effective in the production of roentgen-rays—the other half being suppressed by the rectifier. If it were possible to measure the effective (r.m.s.) voltage during only the useful half-cycle, then the results would undoubtedly be directly comparable with those for a full-wave rectifier.

For a full-wave rectifier the effective voltage, *E*, (r.m.s.) is given by

$$E_{1/2}(\text{r.m.s.}) = E(\text{peak}) \sqrt{\frac{\int_0^{2\pi} \sin^2 \omega t \, dt}{2\pi}} \quad (1)$$

$$= \frac{\sqrt{2}}{2} E(\text{peak}) = .71 E(\text{peak}).$$

For a pure sine wave this may be divided into two parts

$$\begin{aligned} E_{1/2}(\text{r.m.s.}) \\ &= E(\text{peak}) \sqrt{\frac{\int_0^{\pi} \sin^2 \omega t \, dt}{2\pi} + \frac{\int_{\pi}^{2\pi} \sin^2 \omega t \, dt}{2\pi}} \\ &= \frac{\sqrt{2}}{2} E(\text{peak}) = .71 E(\text{peak}). \end{aligned} \quad (2)$$

If, however, we consider one-half of the wave to be suppressed, and therefore useless, we have for a half-wave sine generator

$$\begin{aligned} E_{1/2}(\text{r.m.s.}) &= \frac{\sqrt{2}}{2} E_{2/2}(\text{r.m.s.}) \\ &= .71 E_{2/2}(\text{r.m.s.}) \\ &= .5 E(\text{peak}). \end{aligned} \quad (3)$$

We may apply this result to the ideal case of a half sine wave and full sine wave voltage of the same peak value. It would be observed that the r.m.s. voltage read over the full cycle on the half-wave generator must be multiplied by $\sqrt{2}$ to give the same r.m.s. voltage as for the full-wave generator.

The voltage wave form, however, in the usual roentgen-ray generator is not a pure sine wave (section d) because of the large electrical regulation of the transformer and the reaction of the roentgen tube. Analysis of the actual wave form by Fourier series would show each useful half-wave to correspond to a wave-form having a predominant 3d harmonic and less important harmonics of higher order. We have then a complex wave form for which the r.m.s. voltage is no longer given by (2) but rather by the following:

$$\begin{aligned} E_{2/2}(\text{r.m.s.}) \\ &= \frac{1}{\sqrt{2\pi}} \sqrt{\int_0^{\pi} \left[\sum E_b \sin(b\omega t + \theta_b) \right]^2 dt} \\ &\quad + \int_{\pi}^{2\pi} \left[\sum E_b \sin(b\omega t + \theta_b) \right]^2 dt. \end{aligned} \quad (4)$$

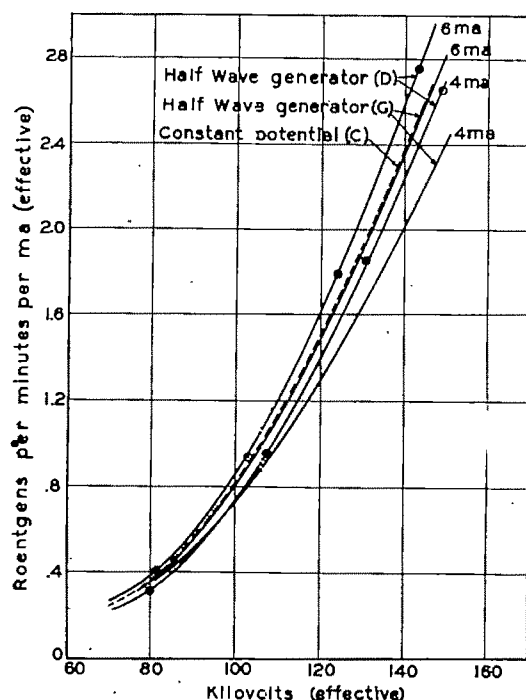


FIG. 7. Output per effective milliampere as a function of the effective voltage for two half-wave valve tube rectifiers, using different high tension transformers.

Solution of this equation for one half-wave only shows that equation (3) relating the r.m.s. value during a half-cycle to the r.m.s. value over a full cycle is valid only when there are no strong even harmonics present. Since, as pointed out, the wave form is composed predominantly of the 1st and 3d harmonics, we can, to a first approximation, obtain a measure of the effective voltage during the useful part of the cycle by multiplying the measured value by the $\sqrt{2}$. This type of correction is of course unnecessary for any phenomena utilizing the full cycle of the voltage wave, which includes all other common roentgen-ray generators.

By a similar procedure we should also correct the effective (r.m.s.) tube current readings to apply only during the useful half of the cycle. Making the same assumptions for the current wave form as were made for the voltage wave form, it is found that the r.m.s. current values over a full cycle as read on the meter, should be

reduced by a factor of $\sqrt{\frac{1}{2}}$ which is equivalent to increasing the output per effective ma. during the useful half-cycle by the factor $\sqrt{2}$.

Outputs per effective milliampere, during the useful part of the cycle, obtained for the two half-wave generators *D* and *G*, are plotted in Figure 7 after the measured tube currents, and voltages were thus corrected by the factors $\sqrt{\frac{1}{2}}$ and $\sqrt{2}$, respectively. The broken line curve is for the same tube on constant potential. While the agreement between the three generators is not as close as in the case of the full-wave generators, the spread of the outputs, at a given voltage, is not nearly so large as in the case of equal peak voltages (Figs. 4 and 5). As shown below, the quality of these radiations at any given effective voltage is very nearly the same, thus bearing out our earlier findings on other generators.

(c) *Quality as related to voltage measurements.*

Ordinarily it has been assumed that at a given peak voltage, copper absorption curves obtained under different tube currents will be the same. This is based upon the further assumption that the output per

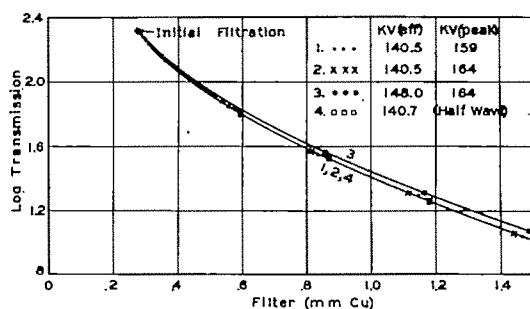


FIG. 8. Copper absorption curves showing the relationship between the roentgen-ray quality and the effective voltage as the tube load is changed.

average milliampere of a tube does not vary with the load. We have just shown, in the case of all but constant potential generators, that this assumption does not hold for changes in tube current even as small as 2 ma. On the other hand, it has been shown that at any tube current the quality

of the roentgen-ray beam is the same at a given effective (r.m.s.) voltage.¹⁹

The curves in Figure 8 show a very sensitive test of the relationship of quality to voltage. These were made with the full wave generator *E*, since in this case variations in tube current had the least effect on the output per milliampere. Curves 1 (dots) and 2 (crosses) were obtained respectively with the same effective voltage (140.5) but with peak voltages of 159 and 164 kv., the peak voltage change being caused by a change in tube current of 2 to 4 ma., respectively. Curves 2 and 3 (circles) were for the same peak voltage (164 kv.) but with respective effective voltages of 140.5 and 148 kv., and respective tube currents of 4 and 2 ma. From these, we see that (a) so long as the effective voltage is maintained constant, the absorption curves (hence roentgen-ray quality) are the same (curves 1 and 2); (b) a change in tube current of 2 ma., with the same peak voltage, causes an appreciable change of quality (curves 2 and 3).

Similar results were obtained using the half-wave generator *D*, after making correction as in section (b) for the suppressed half of the cycle which is ineffective in

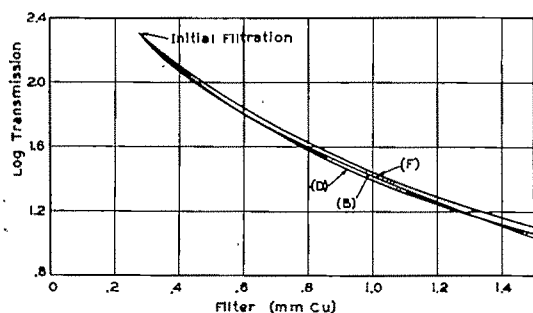


FIG. 9. Copper absorption curves for three generators of different type, operated at approximately the same effective voltage.

Generator *F*—141.7 kv. (effective)—143 kv. (peak).
Generator *B*—143.0 kv. (effective)—192 kv. (peak).
Generator *D*—144.0 kv. (effective)—180 kv. (peak).

roentgen-ray production. Curve 4 (squares) was obtained with the generator (*D*) operated at 99.7 kv. (effective, measured) or 140.5 kv. (effective, corrected), showing a

¹⁹ See footnote No. 9.

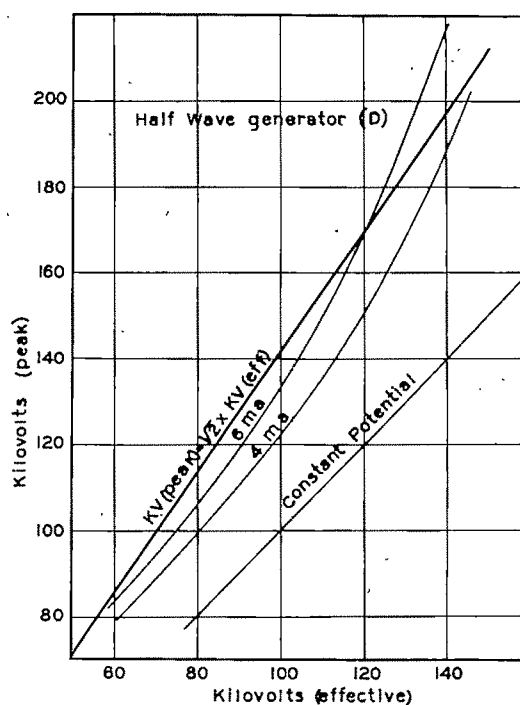


FIG. 10. Relationship between effective and peak voltage for a half-wave rectifier.

very close agreement between the qualities obtained with it and the full-wave generator (*E*).

Finally, Figure 9 gives the copper absorption curves for generators *F*, *B*, and *D* at approximately the same effective voltage but at widely different peak voltages, and shows the close relationship between the effective voltage and quality. The operating conditions are given in the legend. These curves show the qualities of the radiations to be the same; in section (b) it was found that the outputs per eff. ma. were practically the same, so it may be concluded that the radiations are essentially alike.

(d) Changes in voltage wave form.

Changes in the voltage wave form, brought about largely by poor electrical regulation of the transformer, appear to be the principal cause of the irregularity reported above. Information regarding the wave shape of the voltage applied to the tube may be obtained from the measurements already recorded, so that oscillographic examination of the wave form,

which is laborious under such varied conditions, need not be resorted to.

The general wave form may be inferred from the relationship between the effective (r.m.s.) and peak voltage. These are given in Figure 10 for the half-wave generator (D) and in Figure 11 for the half-wave (G)

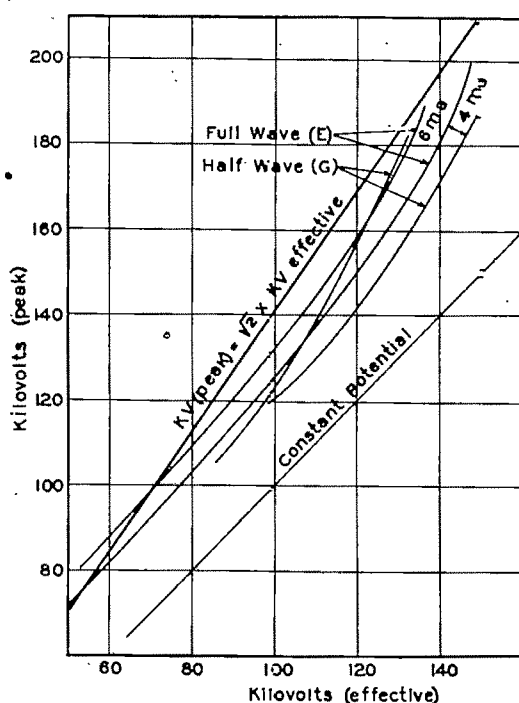


FIG. 11. Relationship between effective and peak voltage for a half-wave and full-wave valve tube rectifier, using the same transformer.

and full-wave (E) generator employing the same transformer.²⁰ The heavy straight line on each plot is for the case of a pure sine wave where $kv. (peak) = \sqrt{2} kv. (effective)$. It is evident that, where the curve for a particular generator and tube current lies below the line for a sine wave, a relatively broad flat-topped voltage wave form is indicated which approaches constant potential as the limit. Where the curve lies above the line $kv. (peak) = \sqrt{2} kv. (effective)$, a relatively narrow or peaked voltage wave form is indicated.

Thus, we find that if the tube current at a given peak voltage is increased, there is a

²⁰ Similar curves for generator B are given in Figure 7B of Research Paper No. 491.

marked decrease in the effective voltage, indicating a narrowing of the voltage wave form and causing a corresponding change in quality (a change corresponding to a lower constant potential). The effect on a given transformer in passing from full-wave to half-wave rectification is indicated by the curves in Figure 11. For a given average tube current of 4 ma. and the same peak voltage, an increase in the effective voltage in going from full- to half-wave is found. This indicates a broadening of the wave form and an increase in the hardness of the radiation; which is to be expected, since the half-wave generator draws a larger maximum tube current during the cycle and flattens out the wave.

These curves likewise show to what extent we may rely upon the assumption, involved in equation (3) and used in arriving at the effective voltage in the case of half-wave generators. For example, it is found in Figure 11, that the 6 ma. curve for generator G approaches nearer a sine wave value than the 4 ma. curve; hence should yield more nearly the normal output per milliamper at that effective voltage. This is found to be the case for the same 6 ma. in Figure 7.

IV. CONCLUSIONS

The experimental results presented in this paper corroborate in detail and further extend our earlier findings regarding the relationships between roentgen-ray tube output and the applied voltage and current supplied by different types of high voltage generator, in the following essentials:

1. For a given effective (r.m.s.) tube voltage, the roentgen-ray outputs per effective milliamper of tube current for all roentgen-ray generators are much more nearly the same than for any other type of voltage and current measurement. The variation of output per effective milliamper with tube current is small; hence, results obtained at one tube current are comparable with results obtained at some other tube current.

2. Roentgen-ray qualities at a given ef-

fective voltage are nearly the same for all generators. This means, in effect, that the output and quality of any generator may be reduced to terms of an equivalent output and quality obtained with constant potential which, in itself, is perfectly definite.

3. Ripple in constant potential generators of 1 to 10 per cent causes no appreciable differences as far as concerns the usual quality and quantity measurements.

4. Effective (r.m.s.) current and voltage measurements on a half-wave generator must be suitably corrected for the useless half-cycle when using the customary types of r.m.s. reading meters.

5. In the comparison of half-wave and full-wave generators with constant potential at given peak voltages and tube currents, there is no simple relationship between the roentgen-ray output or quality.

6. The specification of roentgen-ray output in terms of average tube current and peak voltage is indefinite because of voltage wave form distortion with change in load.

This investigation has been made possible through the cordial cooperation of the American x-ray equipment manufacturers, to whom we express our appreciation.



ENERGY CONSIDERATIONS IN HIGH VOLTAGE THERAPY

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ABSTRACT

The relation between roentgens and energy is discussed, and the energy per cm.² per roentgen plotted for the range 100 to 2,200 kv. Calculated values of attenuation and absorption coefficients are given for the same range.

The number of roentgens required to produce an erythema is calculated on certain assumptions which cannot be justified theoretically, but give fair agreement with observation. The total energy delivered under the same conditions is calculated.

QUANTITY OF RADIATION

MUCH has been said and written both for and against the roentgen unit, but the fact remains that its use provides the only convenient method available for measuring the quantity of radiation, or, as it is called, the x-ray dose. The dose in roentgens can be measured quite readily and with sufficient accuracy for all practical purposes and we can reasonably expect that a given number of roentgens will always produce the same effect under the same conditions. This is satisfactory in practice as long as the problems dealt with are similar in nature and the quality of radiation is the same, but we have no right to expect that a given number of roentgens will produce the same effect regardless of the quality of the radiation. As a matter of fact, we can expect this to be so only in very special cases. It is much more reasonable to assume that equal effects are produced when equal quantities of energy are absorbed in a given volume. We cannot assert, offhand, that this must be true, but we can assume that it is true and see if it leads to conclusions which agree with observation. The assumption appears to be reasonable if we confine ourselves to hard

radiation so that we may neglect the effect of photo-electrons completely. The error in so doing is at most a few per cent. Our assumption becomes still more reasonable when we consider the case of a fairly large beam directed against an absorbing body sufficiently large to absorb all or nearly all of the energy in the beam, for then, as the radiation in the hard beam becomes degraded by scattering, a large fraction is ultimately absorbed as radiation of the same quality as the softer beam.

Such differences as seem to exist between single and multiple celled organisms in regard to their sensitiveness to radiation at different wave lengths is of no importance in the case here considered, for in practical application of roentgen rays in deep therapy we are dealing with a heterogeneous mass of highly complex material, and the best we can do is to assume that the destruction in a given volume is proportional to the energy absorbed in this volume, the proportionality factor depending on the type of cell, but not on wave length.

QUALITY OF RADIATION

By quality of radiation we mean the spectral distribution of the energy. The short wave limit depends only on the maximum voltage applied to the roentgen tube, whereas the distribution of energy depends on the voltage source, target material, and on the kind and thickness of filter. If it is desired to use hard radiation, high voltage together with filters of high atomic numbers is required. In the wave length region with which we are here concerned, the photo-electric absorption is still important in the case of elements of high atomic numbers such as lead, gold, and platinum, and we can therefore take advantage of the

preferential absorption of the longer wave lengths. Therefore, the higher the atomic number of the filter is, the harder will the radiation be for a given sacrifice in energy.

As the action of the filter is purely to attenuate by scattering or absorption the softer part of the radiation, more than the harder, we cannot have hard radiation left unless it was there to start with, and it is therefore important that we start out with a spectrum which is as rich as possible in hard radiation, if hard radiation is desired. The hardest radiation produced depends only on the maximum voltage, but the amount of energy in the form of hard radiation depends on the shape of the voltage and current wave. Thus the spectrum which is richest in hard radiation is produced when the potential on the roentgen tube is always at maximum when current flows through the tube. This is the case when constant potential is used or with alternating voltage, if the filament is arranged to furnish electrons only when the voltage is at or near its maximum value.

As far as the quality of radiation is concerned, there is thus little choice between constant and alternating potential. Rectification has, of course, no influence on the

spectrum, provided the rectifier is satisfactory. With the mechanical rectifier as generally used, it is another matter. There, as with the induction coil, the voltage wave is usually so steep, i.e., of so short duration, that very little hard radiation is produced.

It is not usually convenient to specify the spectral distribution of energy in a roentgen-ray beam and for this reason it is practical to characterize the beam by its equivalent wave length or equivalent voltage. By the equivalent wave length λ_e , we mean that wave length of monochromatic radiation which has some predetermined measurable property, in common with the beam in question. For our present purpose, the property most suitable would seem to be the attenuation in water.

The equivalent voltage V_e is then the voltage required to produce radiation of the equivalent wave length and is given by Einstein's equation:

$$(1) \quad h\nu = eV$$

$$(2) \quad V_e = \frac{hc}{e\lambda_e} = \frac{12354}{\lambda_e}$$

V_e in kilovolts and λ_e in x -units. 1 x -unit = 10^{-8} Å = 10^{-11} cm.

The calculations to follow are made for

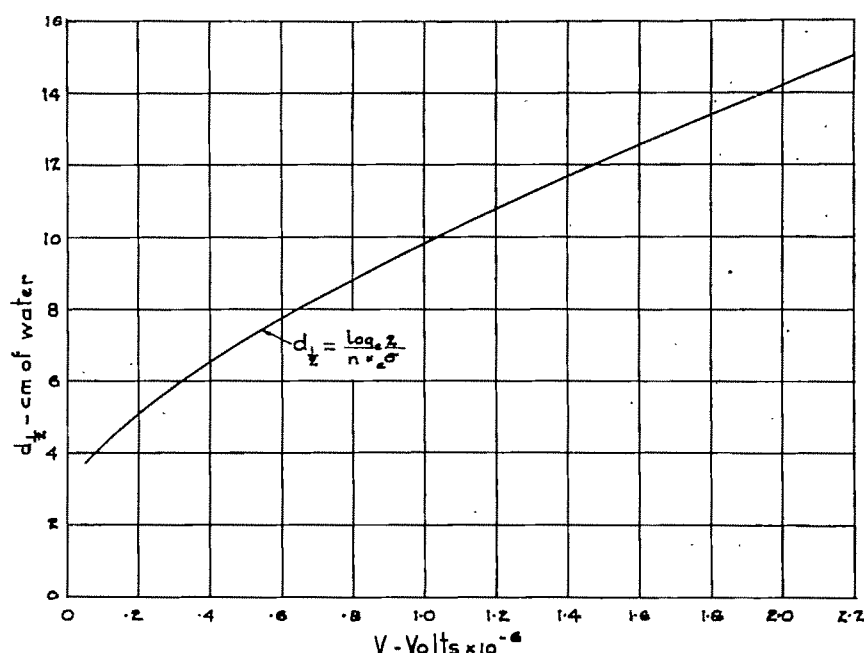


FIG. 1. Calculated half-value layer of water for monochromatic radiation 100 to 2,200 kv.

monochromatic radiation and it is clear that they hold closely only for this case. We may, however, assume that the equivalent wave length as here defined has sufficient meaning to permit us to draw conclusions as to the effects of a heterogeneous beam of radiation, such as we are forced to use in practice.

equivalent voltage is then determined by comparing the measured value of $d_{1/2}$ with the half-value layer of water for monochromatic radiation. In Figure 1 are shown half-value layers of water for monochromatic radiation from 100 to 2,200 kilovolts. The curve has been calculated by using values of the attenuation coefficient de-

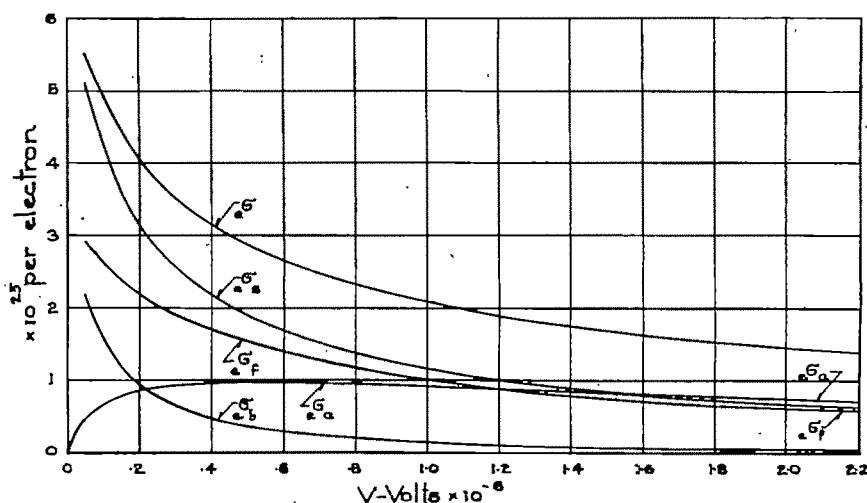


FIG. 2. Scattering per electron calculated from the Klein-Nishina formula. Monochromatic radiation. σ = total attenuation; σ_s = total scattered radiation; σ_f = forward scattered radiation; σ_b = backward scattered radiation; σ_a = true absorption, recoil electron.

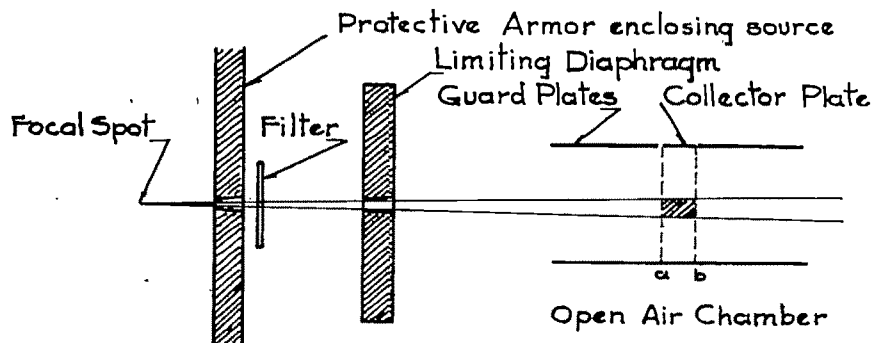


FIG. 3. Arrangement for measuring radiation in roentgens.

The attenuation in water of the radiation from a roentgen tube is most conveniently determined by measuring the half-value layer of water. This is done with the tube operated as it is to be used, and the filters in place. A very small beam must be used and care must be taken that only the direct beam enters the measuring chamber. The

terminated from the formula given by Klein and Nishina.¹

In Figure 2 the curve marked σ is the attenuation coefficient thus determined. We have checked the value of σ with monochromatic radiation of wave length $\lambda = 24$ x-units and found it accurate within the

¹ Klein O., and Nishina, Y. *Zschr. f. Physik*, 1928, 52, 867.

probable error of the measurement which is about 2 per cent.

THE ROENTGEN

Before entering upon our main theme, the absorption of radiation in water, it is necessary to discuss the measurement of radiation in roentgens and to convert roentgens into units of energy, i.e., ergs. When a quantity of radiation in the form of a small beam of homogeneous roentgen rays falls upon a substance such as air, the beam, in passing through a thin layer of the substance, will be attenuated by the amount

$$(3) \quad E = \mu n E_0$$

Where E_0 is the energy falling on the layer, while n is the number of electrons in the layer, μ is the attenuation coefficient per electron and may be written

$$(4) \quad \mu = \tau + \sigma$$

Here τ is the photo-electric absorption coefficient per electron and can be neglected in air when V_0 is greater than 100 kv. σ is the energy per unit of energy of the beam which is removed by each electron in interactions in which the energy is divided between the electron and degraded radiation. We can therefore express the attenuation coefficient

$$(5) \quad \mu = \sigma = \sigma_a + \sigma_d$$

Where σ_a is the true absorption coefficient per electron, i.e., fraction of energy taken up by the electron, while σ_d represents the energy in the degraded radiation. Figure 3 shows schematically an arrangement suitable for measuring hard x-rays in roentgens. A small, well-defined beam is used, and the limiting diaphragm must be so arranged that scattered roentgen rays and electrons from the filter, as well as from the diaphragm, are prevented, as far as possible, from reaching the measuring volume between (a) and (b). For other precautions, reference may be had to the very careful investigations by Dr. Lauriston S. Taylor of the U. S. Bureau of Standards. Under these conditions, the number of ions formed between (a) and (b), and collected on the collector plate, can be

assumed to be proportional to the energy actually absorbed in the shaded volume between (a) and (b). It is true that many of the recoil electrons which start out in the shaded volume are not completely absorbed between (a) and (b), but this loss is exactly compensated by the gain of electrons which originate in front of (a).

It is advisable to construct the measuring chamber of aluminum or other light material and to avoid the use of lead around the chamber. If the diameter of the beam is small, say less than 1 per cent of the distance in which the radiation loses one-half its energy, then the fraction of degraded radiation which is absorbed in the measuring volume directly, or scattered back from the surroundings, may be neglected, and the energy E_a actually absorbed per cm.³ in the shaded volume is

$$(6) \quad E_a = \sigma_a E_0 n_a$$

E_0 being the energy per cm.² of the beam at the point where the measurement is made, say at (a) $n_a = 3.92 \times 10^{20}$ is the number of electrons per cm.³ in the air. It is difficult to measure E_a directly in energy units, but we can calculate the energy if we know the number of ions produced by the recoil electrons originating in 1 cm.³, for each ion removes 32 electron volts from the recoil electron and therefore 1 e.s.u., in the form of ions, requires that an energy of $32/300 = 0.107$ ergs shall have been absorbed in 1 cm.³. But by definition, the quantity of radiation which produces 1 e.s.u. in 1 cm.³ of air, is 1 roentgen, so we have

$$(7) \quad E_a = 0.107 \text{ ergs per cm.}^3 \text{ per roentgen.}$$

Let R be the number of roentgens delivered at the point (a), then

$$(8) \quad E = 0.107 R \text{ ergs will be absorbed per cm.}^3 \text{ at the point (a)}$$

Combining this result with equation (6) we see that

$$(9) \quad E_0 = \frac{0.107 R}{n_a \sigma_a} \text{ is the number of ergs delivered per cm.}^2 \text{ at the point (a) when the total quantity of radiation is } R \text{ roentgens.}$$

σ_a , the scattering absorption coefficient per electron, may be calculated by making use of the expressions for the distribution of the scattered energy developed by Klein and Nishina.¹ The calculated values of σ_a for several wave lengths are plotted in Figure 2 against V as abscissa. Inserting these calculated values in equation (9), and taking $R=1$, we obtain the actual energy in ergs per cm.² for a quantity of radiation equal to 1 roentgen. This is shown in Figure 4. It is not safe to extrapolate this curve much below $V=100$ kv. because of the photoelectric absorption which we have neglected.

By a broad beam we mean a beam, the diameter of which is at least equal to the distance in which the energy is reduced to one-half.

As in the previous case, it is important for our consideration that the filter and the limiting diaphragm do not contribute much scattered radiation to the absorbing body. This condition is best fulfilled if the absorber is some distance from the limiting diaphragm. Under these conditions we permit a quantity of radiation equal to R roentgens to fall on the surface of the absorber.

We shall now determine the number of

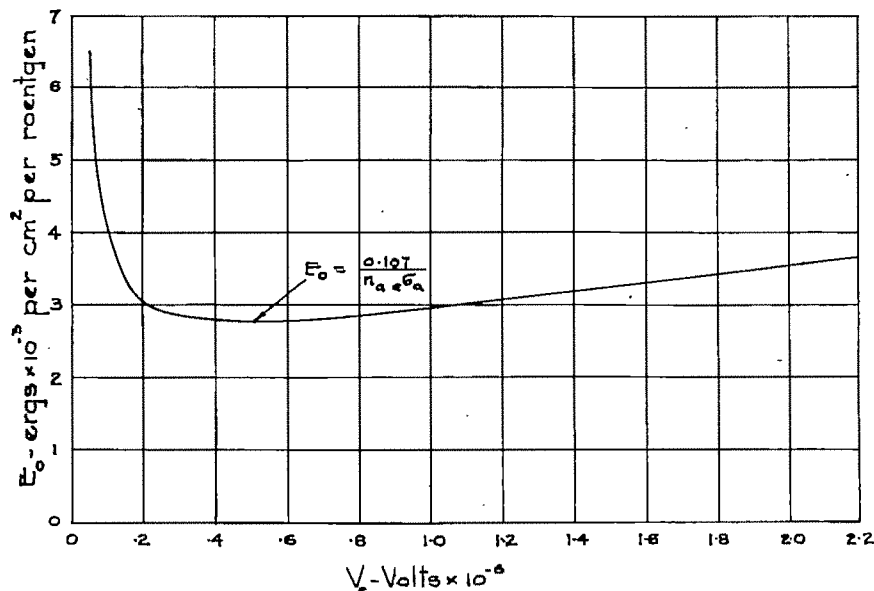


FIG. 4. Total energy falling on 1 cm.² when 1 roentgen is delivered.

ABSORPTION IN WATER

The general problem of absorption in a large body is extremely complex and it is doubtful if we should gain much useful information by attempting a detailed solution. It seems, therefore, advisable for our present purpose, to limit ourselves to conditions such as are used in deep therapy, and apply certain general energy considerations to the case.

We consider a broad beam of x-rays falling upon a body sufficiently large to absorb nearly all of the energy in the beam.

roentgens required at various wave lengths, if it is desired that a constant amount of energy shall be absorbed per cm.² of a surface layer, say 1 mm. thick.

The energy absorbed in this surface layer is given approximately by

$$(10) \quad E_s = (\sigma_a + \sigma_b) n_s E_0$$

where $\sigma_a E_0$ as before, is that fraction of the energy which is absorbed by the recoil electron, while $\sigma_b E_0$ is the fraction which is scattered backward in the form of radiation, n_s is the number of electrons per cm.²

of the surface layer under consideration. For water $n_s = 3.36 \times 10^{22}$ electrons. That we must here use σ_b rather than $\sigma_s = \sigma_b + \sigma_f$ is seen, when we consider that the fraction $\sigma_b E_0$ is either absorbed in the surface layer, or compensated for by radiation which is scattered back from layers farther on along the beam, while $\sigma_f E_0$ being the fraction scattered forward, is not compensated for, and thus does not contribute to the surface absorption. It is true that the compensation is not complete, owing to the

using the value of E_0 given by equation (9), we get

$$(11) \quad R = E_s \frac{\sigma_a}{\sigma_a + \sigma_b} \cdot \frac{n_s}{n_s} \cdot \frac{1}{0.107} \text{ roentgens.}$$

Here all quantities are known and we may determine R for any desired value of E_s and V_s . This has been done for $E_s = 1.4 \times 10^4$ ergs per cm.² in a layer 1 mm. thick for a number of wave lengths and the results plotted in Figure 5.

The values chosen for E_s and for the

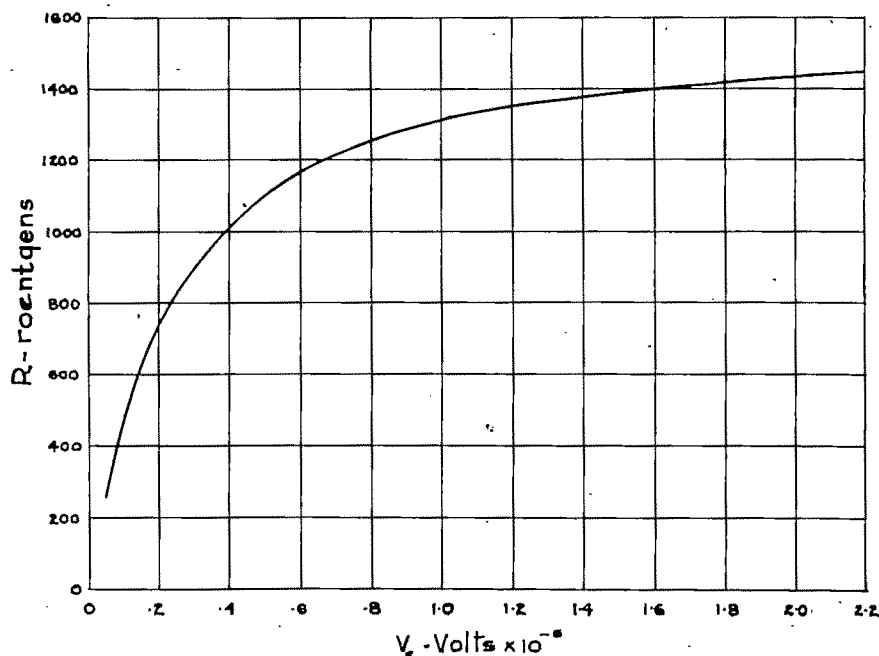


FIG. 5. Total number of roentgens required to cause absorption of 1.4×10^4 ergs per cm.² of a surface layer 1 mm. thick. Calculated. A curve of the erythema dose can be expected to be similar.

attenuation of E along the path, but the deficiency will tend to balance the effect of multiple scattering and ultimate absorption of the degraded radiation photo-electrically.

Klein and Nishina have developed an expression for the energy of scattered radiation per unit solid angle as a function of the wave length.

If we integrate this expression between the limits $\pi/2$ and π and evaluate the integral for several values of V_s , we obtain the curve marked σ_b in Figure 2.

Returning now to equation (10), and

thickness of the layer considered are, of course, somewhat arbitrary, and we should therefore not attach too much significance to the numerical values given in the plot. The general trend, however, is quite clear, and relative values are uncertain only because of the uncertainty involved in setting the absorption coefficient equal to $\sigma_a + \sigma_b$. This would seem to be a sufficiently close approximation for our purpose, although certainly not entirely justifiable on theoretical grounds.

It is an interesting fact that in the region below 1,500 kv., on the average very nearly

half of the energy in the interaction between the radiation and an electron is given to the electron or scattered backward while the other half is scattered forward. By using the values shown in Figure 2, it may be seen that the maximum deviation from this rule is less than 5 per cent, so that we may write

$$(12) \quad \sigma_a + \sigma_b = \sigma_f = \frac{1}{2} \sigma$$

Instead of equation (10) we can therefore write

$$(13) \quad E_s = \frac{1}{2} \sigma n_s E_0$$

spectral distribution of energy is such that the equivalent voltage is about one-half to two-thirds of the maximum voltage, depending on the filtration. Keeping this in mind, we see that the curve in Figure 5 represents fairly well the number of roentgens required to produce an erythema of the skin with the various kinds of radiation employed in deep therapy.

It is interesting now to determine the total amount of energy which under these conditions has been delivered to the body for each cm.² of surface. This we obtain most simply by solving equation (10) for

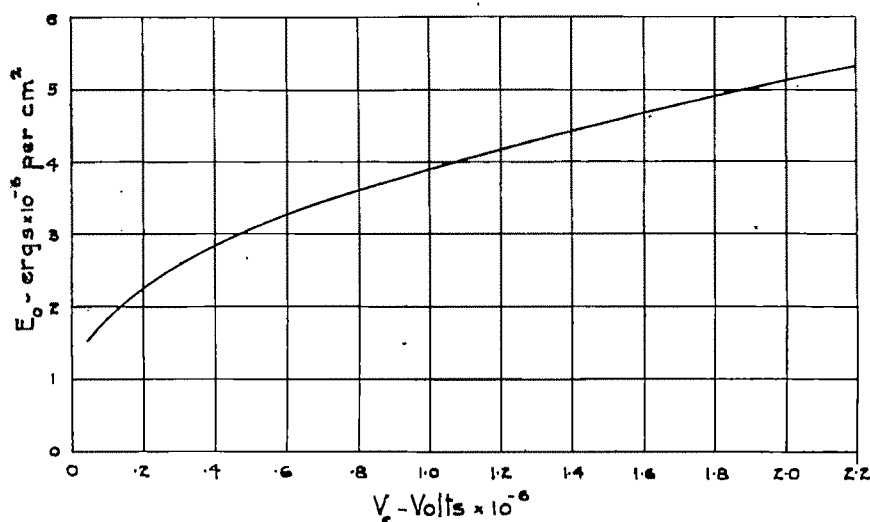


FIG. 6. Total energy delivered for constant absorption in the surface layer.

This would not change the curve in Figure 5 appreciably.

The curve in Figure 5 thus represents the number of roentgens which at a given wave length must be delivered in order that 1.4×10^4 ergs may be absorbed per cm.² of a surface layer 1 mm. thick. If, now, this absorbing body is the human body, and if we assume that 1.4×10^4 ergs absorbed per cm.² of the skin produces a certain recognizable reaction on the skin, then we should expect that this effect will be produced when we deliver the number of roentgens given by the curve in Figure 5 for x-rays of a given equivalent voltage.

In the usual type of x-ray equipment, the

$E_s = 1.4 \times 10^4$ ergs per cm.², thus obtaining E_0 as a function of the equivalent voltage. The results of this computation are shown in Figure 6 which therefore may be taken to represent the relative merits of radiation of various degrees of hardness, on the assumption that we are interested solely in delivering the greatest amount of energy possible with a given skin effect.

In the case of deep-lying tumors, say 10 or more cm. below the surface, the comparison obviously is even more in favor of the hard radiation. The soft radiation is attenuated so rapidly that most of the energy is used up in destroying the overlying normal tissue and very little is ab-

sorbed in the tumor. This is particularly important when small ports are used, as the attenuation is then greatest. It is for this reason that the radiologist who attempts to use low voltage equipment for deep therapy work finds himself forced to use large portals, and he does not have an opportunity to use his skill and judgment

in using multiple portals adapted to the particular case in hand.

Since the present paper was submitted for publication, the author has thought it of interest to treat in a similar manner the voltage range in which the photo-electric absorption is not negligible. This will be presented in a subsequent paper to appear in an early issue of this Journal.



THE PHYSICAL FOUNDATIONS OF CHEST ROENTGENOGRAPHY*

PART II. THE DEPENDENCE OF SHARPNESS UPON MOVEMENT OF LUNG TISSUES AND SIZE OF FOCAL SPOT

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THE movement of the lung tissues with the heart beat, and the limitations in the ability of the focal spot to stand, without damage, the energy applied to the roentgen tube, constitute the most difficult phase of the problem of definition or sharpness in chest roentgenography. Practically the whole of the electrical energy used for the production of roentgen rays is concentrated on the focal spot. A tiny fraction of this energy emerges from the focal spot in the form of roentgen rays, but the remainder serves merely to heat a thin layer of metal of the area of the focal spot. This heat is radiated and conducted away rather slowly, so that, in the case of short exposures, the immediate effect is to cause a rapid rise in temperature of the focal spot surface. Tungsten, the metal commonly used for the active face of the target, has the highest melting point of any metal known and can safely be heated to a higher temperature than any other target material. Even so, the focal spot on a tungsten target must be large enough to affect very noticeably the sharpness of roentgen-ray shadows.

The power that may be applied to a given size of focal spot increases slightly as exposure time is decreased,² but, in the main, the increased tube currents necessitated by shorter exposure times must be accommodated by a nearly proportional increase in area of focal spot. The larger focal spot offsets, to a greater or less degree, the gain in sharpness secured by shortening the exposure time. How, then, should exposure time and focal spot size be mutually adjusted to secure the best resultant roentgenographic sharpness?

In an ingenious method of attacking this

problem developed by Bouwers,^{3,4} an analysis was made of the way in which various factors influence the degree of diffusion of the edge of a shadow as projected upon the film. The edge of any shadow in the roentgenogram may be diffused by reason of geometric factors, such as the size of the focal spot combined with the relative distances of the object and the focal spot from the film. The edge of the shadow may also be diffused by the movement of the object during the exposure. Any such diffusion may cause the edge of the shadow to have a perceptible width. If this width is small, e.g., less than 0.1 mm., it appears fairly sharp to the naked eye; but if it is wider than 0.1 mm., as is usual in roentgenography, it appears more or less diffuse.

The width of the diffuse edge of a shadow may be called the unsharpness. If the object of interest in the roentgenogram, such as a portion of lung tissue, moves during the exposure, the edge of the shadow of the object is diffused to the extent that the shadow has moved. This distance is the product of the speed of movement and the exposure time. For instance, if the speed of movement is 10 mm. per second, and the exposure time $1/5$ second, the shadow has moved $1/5$ of 10 mm., or 2 mm. The width of diffusion of the edge of a shadow arising from movement is called *movement unsharpness*. Movement unsharpness is illustrated in Figure 1(a) which assumes a point source of roentgen rays.

If the object is stationary during the exposure, movement unsharpness is avoided, but the edge of its shadow may be diffused somewhat because of the size of the focal spot and the distance of the object from the film. In this case the diffusion at the

* Communication No. 508 from the Kodak Research Laboratories.

edge of the shadow is the penumbra formed by the width of the focal spot, as illustrated in the diagram of Figure 1(b), and is called *geometric unsharpness*. If d is the width of the focal spot, OF the object-film distance, and OT the object-target distance, geometric unsharpness, U_g , is equal to $OF/OT \times d$.

THE CALCULATION OF UNSHARPNESS

It is of interest to calculate movement unsharpness, geometric unsharpness, and total unsharpness for a series of exposure times, assuming typical conditions used in chest roentgenography. From data to be discussed later, a figure for a typical velocity of movement of lung tissue may be

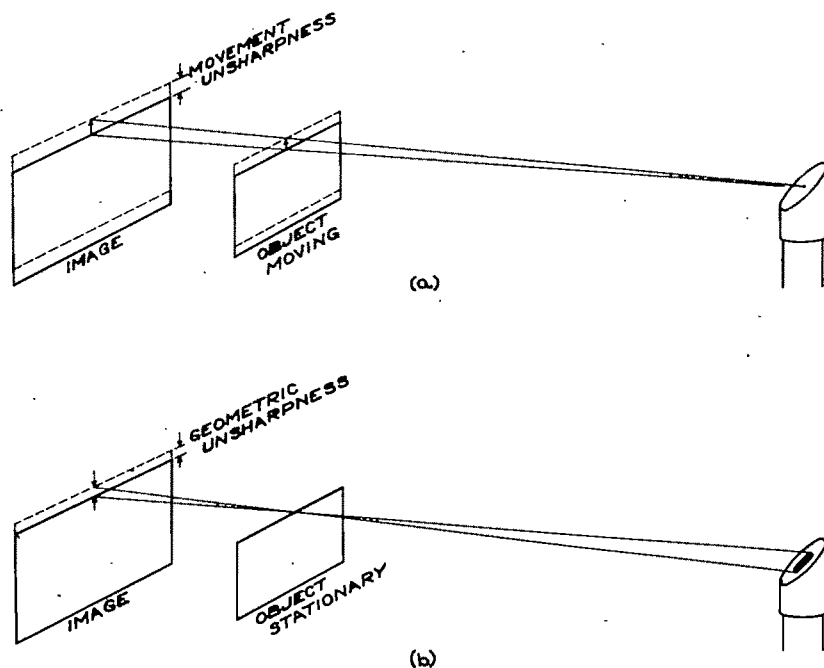


FIG. 1. (a) The edge of a shadow is blurred by movement to the extent that the shadow has moved during the exposure, giving rise to movement unsharpness. (b) The edge of a shadow may also be diffused by the size of the focal spot and the distance of the object from the film; the width of the penumbra at the edge of a shadow is designated as geometric unsharpness.

The total width of the diffuse edge of a shadow, owing to the combination of the effects of movement of the object and the penumbral shadow cast by the focal spot, is equivalent to the sum of the movement unsharpness and geometric unsharpness (Fig. 2), and is called *total unsharpness*.

Movement unsharpness may be diminished by shortening the exposure time; however, this must be accompanied by an increase in tube current in order to afford adequate exposure of the roentgenogram. The increase in tube current makes necessary an enlargement of the focal spot, with a resulting increase of geometric unsharpness.

taken as 5 millimeters per second. At 80 kv.p. and 6-foot target-film distance, with photographic materials of average speed, an exposure of 20 milliamperere-seconds should be ample for the majority of chests. The calculations will be made for a portion of lung tissue 4 inches from the film (object-film distance = 4 inches). A line focus tube, with anode slope of 20 degrees, is assumed, with a focal spot which appears square as viewed along the path of the central ray. Data supplied by Bouwers^{2,4} are used in computing the size of focal spot and the resulting geometric unsharpness corresponding to each exposure time. The results are recorded in Table 1.

The values of movement unsharpness show that, with a lung tissue speed of 5 millimeters per second, an exposure of $1/40$ or $1/60$ second is short enough to make the movement practically imperceptible in the

second, and at $1/20$ second the total unsharpness is effectively the same as at $1/30$ second. Altogether, the $1/20$ second exposure is to be preferred over the $1/30$ second, since it permits a slightly smaller



FIG. 2. Total unsharpness is the sum of movement unsharpness and geometric unsharpness.

roentgenogram. However, at $1/60$ second the increase in geometric unsharpness more than offsets the decrease in movement unsharpness, with the result that total unsharpness is actually higher at $1/60$ second than at $1/40$ second. In fact, the minimum value of total unsharpness occurs at $1/30$

focal spot and consequently better definition in the more slowly moving portions of the lungs.

Bouwers³ derived a series of equations from which calculations such as those recorded in Table I may readily be made. Movement unsharpness is given by

$$U_m = at \quad (1)$$

where a is the speed of movement in millimeters per second and t is the exposure time.

TABLE I

Exposure Time Seconds	Movement Unsharpness Millimeters	Geometric Unsharpness Millimeters	Total Unsharpness Millimeters
$1/4$	1.25	0.16	1.41
$1/10$	0.50	0.23	0.73
$1/20$	0.25	0.33	0.58
$1/30$	0.17	0.40	0.57
$1/40$	0.12	0.47	0.59
$1/60$	0.08	0.58	0.66
$1/120$	0.04	0.82	0.86

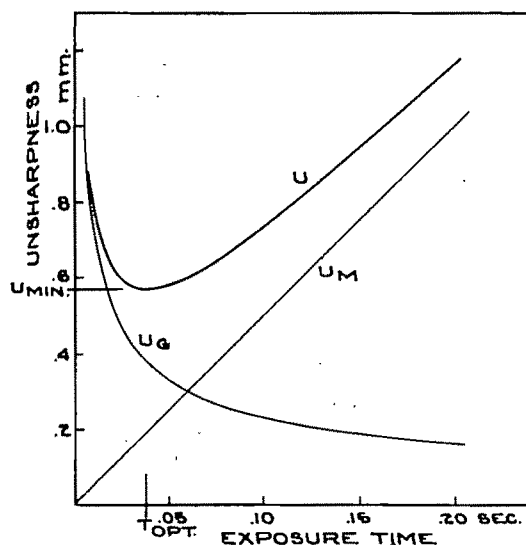


FIG. 3. Unsharpness due to focal spot size (U_g), unsharpness due to movement (U_m), and total unsharpness ($U = U_g + U_m$) as a function of exposure time. These curves are drawn to fit the following conditions; exposure of 20 ma-sec. at 80 kv.p.; 6-foot target-film distance; 4-inch object-film distance; speed of lung tissue movement 5 mm. per sec.; line focus tube with 20-degree anode slope.

Geometric unsharpness is given by the expression

$$U_g = \frac{OF\sqrt{E}}{OT\sqrt{Bt}} \quad (2)$$

where OF is the object-film distance, OT the object-target distance, E is the energy

passed through the focal spot during the exposure expressed in watt-seconds, B is the specific load capacity of the focal spot expressed in watts per square millimeter effective target area, and t is the exposure time. The energy of the exposure E is the product of kilovolts (effective), milliamperes, and exposure time.

The total unsharpness is the sum of the geometric unsharpness and the movement unsharpness, or

$$U = U_g + U_m. \quad (3)$$

Figure 3 shows typical curves of U_g and U_m plotted against exposure time. Curve U_g shows how geometric unsharpness diminishes with increase of exposure time because of the fact that a longer time permits a smaller tube current and therefore a smaller focal spot. Curve U_m shows how movement unsharpness increases in proportion to the time of exposure. The curve for total unsharpness U is found by adding the corresponding values of U_g and U_m . This curve has a minimum, a point at the focal spot size and the exposure time are mutually adjusted to give the least unsharpness or best definition. This means that under the conditions to which this curve is applicable, no possible adjustment of exposure time and focal spot size can give a lesser unsharpness than the minimum value on the curve. The value of minimum unsharpness and of the corresponding exposure time is not affected appreciably by change of target-film distance, but any changes in the other factors, such as speed of film or intensifying screens, the specific load capacity of the focal spot or the speed of movement of the edge of the shadow on the film, will all affect the minimum unsharpness available and the proper adjustment of exposure time and focal spot size to produce minimum unsharpness.

These equations contain the assumption that the specific load capacity of the focal spot does not change with exposure time, whereas, in fact, a focal spot will stand a slightly greater load, in watts per square

millimeter, as exposure time is diminished. This would produce a slight decrease in both optimum exposure time and minimum unsharpness, but these effects are so small they can be neglected in the present stage of the investigation.

The exposure time giving the minimum unsharpness, derived from Bouwers' equations, is

$$t_{opt} = \frac{\sqrt[3]{OF^2 E}}{\sqrt[3]{4a^2 B OT^2}} \quad (4)$$

and may be called the optimum exposure time. When the total unsharpness is a minimum, it may be shown that

$$U_g = 2U_m \quad (5)$$

that is, geometric unsharpness is double that due to movement.

The curve U of Figure 3 has a rather broad "valley" where the effect of a small change in exposure time is compensated for almost exactly by the corresponding change required in the focal spot size. The range of times over which total unsharpness is practically unchanged is, in this case, from 0.02 to 0.07 second. It has already been shown that target-film distance has very little effect upon sharpness in chest roentgenograms, and now it is found that within a certain range, exposure time has practically no influence upon the sharpness; both these conclusions result from the conditions that the focal spot is to be used at or near its maximum load carrying capacity. These facts explain why both practical experience and ordinary methods of experimentation have failed to show that any particular target-film distance and exposure time are clearly the best for chest roentgenography.

In general, it is preferable to choose one of the longer exposure times within the permissible range, since this will allow a smaller focal spot to be used, thereby producing better sharpness in the slower moving or stationary positions of the lungs, and diminishing the power required of the roentgen machine. Usually it is found that

the optimum exposure time can be increased 50 per cent without noticeable change in sharpness.

It is of interest to make a few calculations of the optimum exposure time and minimum unsharpness obtainable with representative conditions of chest roentgenography. For the specific load capacity of the focal spot, Bouwers⁴ gives the value of 250 watts per square millimeter of area measured on the target face; for a 20-degree target face this value becomes 730 watts per square millimeter of effective area as projected in the direction of the central ray. The conditions assumed, as well as the results obtained, are recorded in Table II.

TABLE II

Given Data	Kilovolts peak.....	80
	Kilovolts effective.....	56.6
	Milliamperes-seconds.....	20
	Target-film distance (feet).....	6
	Object-film distance (inches).....	4
	Anode slope (degrees).....	20
	Specific load capacity of focal spot (watts/mm. ²).....	730
Calculated Data	Speed of movement in mm./sec....	5
	Optimum exposure time, t_{opt} (sec.).....	0.033
	Milliamperes for t_{opt}	530
	Focal spot width (mm.) for t_{opt}	6.4
	Minimum unsharpness (mm.).....	0.57
	$3/2 t_{opt}$ (sec.).....	0.057
	Milliamperes for $3/2 t_{opt}$	350
	Focal spot width (mm.) for $3/2 t_{opt}$	5.2
	Total unsharpness for $3/2 t_{opt}$ (mm.).....	0.59

The optimum exposure time comes out practically 1/25 second, the milliamperes required are 530, and the minimum unsharpness is about 0.6 mm. If the optimum exposure time be increased by 50 per cent, to approximately 1/18 second, the unsharpness is not appreciably affected, and the necessary tube current is reduced to about 350 milliamperes.

The following expression for minimum unsharpness may also be derived:

$$U_{min} = 3 \sqrt[3]{\frac{a \overline{OF^2} \left(\frac{E}{OT^2} \right)}{4B}} \quad (6)$$

The discouraging feature of this equation is that minimum unsharpness varies as the cube root of each of the factors under the radical sign, i.e., any material improvements in sharpness will require comparatively large changes in the factors which control sharpness. For instance, if the speed of movement of the lung tissue could be reduced to 1/8 its normal rate, the unsharpness would be reduced to the cube root of 1/8 or to 1/2 the previous unsharpness.

METHODS OF IMPROVING SHARPNESS

Since equation (6) specifies minimum unsharpness in terms of the factors which govern it, it should be profitable to examine this equation to find what factors offer a possibility of material improvement in sharpness. The factor OF , object-film distance, is governed by the size and structure of the patient and is not subject to control. The factor OT , object-target distance, may easily be varied, but the factor E , the energy of the exposure, must be changed with this distance in such a way (in proportion to square of target-film distance) that the ratio E/OT^2 remains practically constant, and the resultant effect upon sharpness is inappreciable. The factor E may be changed independently of target-film distance by variation in tube voltage, or by a change in the speed of the film or intensifying screens. Unsharpness could be diminished by a reduction in E , but to secure such a reduction by increase of tube voltage would result in lower contrast, so that this possibility is limited in its application. Judging from past experience, a gradual increase in speed of films and intensifying screens may be expected, and the reduction in the energy of the exposure by this means will permit a slight reduction in unsharpness. Since all the fundamental factors affecting sharpness are under the cube root sign, a large change must be made in any of them to influence definition materially; the only factors in which large changes appear possible are a , the velocity of movement of lung tissue, and B , the specific load

capacity of the focal spot. Undoubtedly, the speed of lung tissue movement varies considerably during the heart cycle, and if the roentgenographic exposure can be made at the phase of minimum movement; as suggested by McPhedran and Weyl,⁸ an important improvement in sharpness should be obtained.

MOVEMENT OF LUNG TISSUES WITH HEART BEAT

There appears to be no very precise data on the speed of movement of lung tissues in various phases of the heart cycle. Ruggles⁷ has used the method of roentgen cinematography for the study of the heart; and his films show the grosser movements in some of the surrounding lung tissue. An examination of his roentgen-ray motion picture on 16 mm. film, "The Heart in Motion," shows that the lung tissues near the heart tend to follow the movements of the heart itself, but lag behind the more rapid heart movements. The greatest lung movement is near the apex of the heart, and the excursion of the lung tissue at this point appears to be about half that of the heart border.

Figure 4 shows the data obtained by Chamberlain and Dock⁶ in their analysis of roentgenograms taken by Ruggles' method; the existence of a nodal point is shown on the left border of the heart. The tissues in the left lung also seem to oscillate about this node as a center. The excursion of the

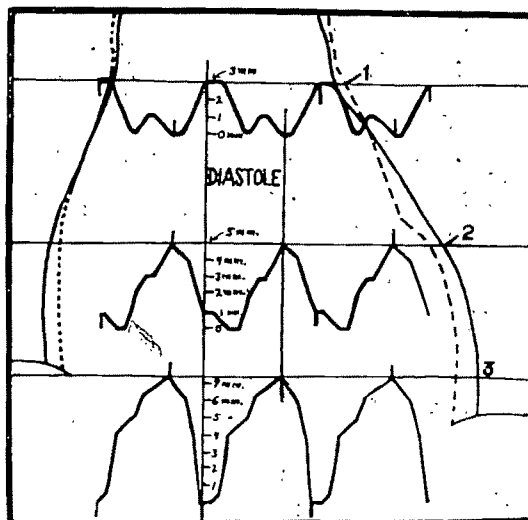


FIG. 4. Chart of heart movement as observed by Chamberlain and Dock.⁶ The roentgencardiograms at the points indicated by numbers enable the speed of the heart movement at these points to be determined at various portions of the heart cycle.

tissue movement diminishes from the heart border toward the periphery of the lung. Chamberlain and Dock's plots of the excursions of the heart border at levels 1, 2, and 3 (Fig. 4) make it possible to derive the speed of movement of these points in various portions of the heart cycle. By estimation of the relative movements of the lung tissue and the heart border, it is possible to obtain a rough approximation of speeds of lung movement. Such procedure indicates the speed of lung tissue near the apex of the heart at the time of most rapid

TABLE III

EFFECTS OF VARIOUS SPEEDS OF TISSUE MOVEMENT UPON OPTIMUM EXPOSURE TIME, TUBE CURRENT, AND MINIMUM UNSHARPNESS. THE CONDITIONS 80 KV.P., 20 MA-SEC. 16-DEGREE ANODE SLOPE, 6-FOOT TARGET-FILM DISTANCE, AND 4-INCH OBJECT-FILM DISTANCE, APPLY TO THESE CALCULATIONS.

Speed of Movement in mm. per sec.		20	10	5	2.5	1
For optimum exposure time	(Optimum exposure time, t_{opt})	0.014	0.022	0.035	0.056	0.10
	(Tube current (ma.).....)	1440	900	570	360	200
	(Focal spot width (mm.).....)	9.5	7.5	6.0	4.7	3.5
	(Minimum unsharpness (mm.).....)	0.84	0.66	0.53	0.42	0.31
For 3/2 optimum exposure time	(Exposure time (sec.).....)	0.021	0.033	0.053	0.084	0.15
	(Tube current (ma.).....)	950	600	380	240	135
	(Focal spot width (mm.).....)	7.7	6.2	4.8	3.9	2.9
	(Unsharpness (mm.).....)	0.87	0.69	0.56	0.44	0.32

movement to be about 20 millimeters per second. Near the upper left border of the heart the maximum speed of the lung tissue seems to be about 10 to 15 millimeters per second. In the center of the left lung the maximum speed may be estimated at about 5 millimeters per second. These pictures

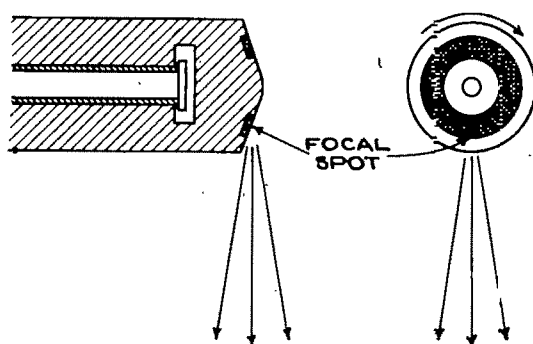


FIG. 5. By means of the rotating target, the effective focal spot can be confined to a small area, while the energy passing through the tube is distributed over the area of a broad ring on the target face.

show very little of the right lung; the movements along the right border of the heart, of course, are less than those on the left.

From an examination of the Ruggles film and of the roentgen cardiograms of Chamberlain and Dock, it seems reasonable to assume that at the most quiescent period of the heart cycle (end of diastole and beginning of systole) the speed of movement of the lung tissue is of the order of $1/8$ the maximum speed. In this case calculation shows that the method of McPhedran and Weyl of synchronizing the roentgenographic exposure with the time of minimum movement could be made to reduce the unsharpness by half. At the same time the optimum exposure time is increased four times, and the tube current reduced to $1/4$ the original value.

The data of Table III show clearly the advantages of a decrease in speed of tissue movement in improvement of definition and reduction of the tube current required for the exposure. The calculations apply to tissue speeds varying from 20 mm. to 1 mm. per second.

THE REDUCTION OF EFFECTIVE FOCAL SPOT SIZE

Minimum unsharpness can also be decreased by increasing the specific load capacity of the focal spot. One method of doing this is the application of the line focus principle. The apparent area (and form) of the focal spot, as projected upon the film, determines the excellence of the definition afforded, whereas the actual area of the focal spot on the target face determines the energy which can safely be applied within a given exposure time. By suitably reducing the anode slope, or the angle between the target face and the central ray, the effective focal spot size is decreased in proportion to its load capacity. An anode slope of 16 degrees, which, according to Andrus and Hambleton,⁸ is permissible at a 6-foot target-film distance, would give a specific load capacity over $2\frac{1}{2}$ times that of a 45-degree anode slope.

Another method of securing a large increase in specific load capacity is to construct the tube so that the anode can rotate on its longitudinal axis;¹ the electron stream from the cathode is focused on an area of the target face some distance away from the center of rotation. The position of the focal spot remains fixed in space, but the rotating target constantly offers a fresh portion of target face to the electron stream, thereby distributing the energy over the area of a broad ring (Fig. 5). According to Bouwers,³ such a rotating target permits an 8-fold increase in specific load capacity. A rotating line focus target would give $8 \times 2\frac{1}{2}$, or 20 times the specific load capacity of a stationary 45-degree target. According to equation (6), minimum unsharpness would be decreased in the ratio of $\sqrt{20}$ to 1 or to 37 per cent of the minimum unsharpness possible with a stationary 45-degree target.

In Table IV are compared the minimum unsharpness values resulting from the use of a 45-degree anode slope, a 16-degree slope, both on a stationary target, and a 16-degree anode slope on a rotating target, all for a speed of movement of lung tissue

of 20 mm. per second. In addition, the fourth column gives the results of combining the 16-degree stationary target with the synchronization of the exposure with the heart cycle, assuming that under these conditions the speed of movement of lung tissue is reduced to 2.5 mm. per second; the fifth column gives the results of combining a 16-degree rotating target with the lower speed of movement afforded by exposure

therefore wise to utilize a method of synchronizing the exposure with the heart cycle along with the use of the rotating target to avoid the necessity for very high tube currents and extremely short exposure times.

If a rotating target tube of reasonable capacity, such as is specified in column 5 of Table IV, is used without the method of exposure synchronization, it will give mini-

TABLE IV
FOR 80 KV.P., 20 MA-SEC. TARGET-FILM DISTANCE OF 6 FEET, AND OBJECT-FILM DISTANCE OF 4 INCHES.*

Type of target	1 Stationary	2 Stationary	3 Rotating	4 Stationary	5 Rotating
Anode slope (degrees)	45	16	16	16	16
Effective specific load capacity of focal spot . . .	350	907	7250	907	7250
Speed of movement in mm./sec.	20	20	20	2.5	2.5
Optimum exposure time, t_{opt} (sec.)	0.019	0.014	0.007	0.056	0.028
Milliamperes for t_{opt}	1050	1440	2870	360	714
Effective focal spot width (mm.) for t_{opt}	13.1	9.5	4.7	4.7	2.4
Minimum unsharpness (mm.)	1.15	0.84	0.42	0.42	0.21
$3/2 t_{opt}$ (sec.)	0.029	0.021	0.0104	0.084	0.042
Milliamperes for $3/2 t_{opt}$	690	952	1920	238	476
Focal spot width (mm.) for t_{opt}	10.6	7.7	3.9	3.9	1.93
Total unsharpness for $3/2 t_{opt}$ (mm.)	1.20	0.87	0.44	0.44	0.22

synchronization. The conditions 80 kv. p., 20 ma-sec., a target-film distance of 6 feet, and an object-film distance of 4 inches apply to these calculations.

It is apparent that the combination of a rotating line focus target with the reduction of the speed of movement of lung tissue decreases the minimum unsharpness very considerably; and unsharpness of only 0.2 mm. in a roentgenographic image may be considered very satisfactory and would represent a marked improvement in sharpness over that of chest techniques now in common use.

The data in Table IV also show that increase of specific load capacity of the focal spot makes a shorter exposure time and a higher tube current necessary to obtain minimum unsharpness, whereas reduction of speed of movement permits a longer exposure with a lower tube current. It is

minimum unsharpness only in the more slowly moving portions of the lungs, but will fail to give the best sharpness in the more rapidly moving portions near the heart. Without exposure synchronization, the wide variation in speed of lung tissues over the whole lung field make it impossible to secure the best sharpness of every portion of the lungs with a single exposure. Shorter exposures, with the correspondingly larger focal spots, will improve definition in the more rapidly moving portions of the lungs, but will decrease the sharpness in the stationary and more slowly moving tissues, whereas the longer exposures, with smaller focal spots, will favor the more slowly moving tissues in the matter of sharpness, at the expense of sharpness in the rapidly moving portions. If, however, the exposure can be synchronized with the phase of minimum movement of the lungs, the speed varia-

tions of the different portions will be greatly reduced, and a more uniform sharpness can be secured over the whole lung field.

The energy, in watt seconds, required for a chest exposure depends upon tube volt-

parent sharpness to some extent. In any case the effect upon sharpness need not be seriously considered in the choice of tube voltage.

Table v also shows that to obtain the best definition in the more rapidly moving portions of the lungs, the tube current with a line focus tube should be in the neighborhood of 1,000 to 3,000 milliamperes at the voltages most commonly used. The greater portion of the lung area, however, probably does not move faster than 5 mm. per second, and if exposures are designed to give the best definition at such a speed, longer exposure times and less power may be used, as shown by the data of Table vi. It seems reasonable, therefore, with the roentgen-ray equipment now available, to attempt to secure the best definition only in those portions of the lungs which are moving less than 5 mm. per second—portions which constitute the greater part of the lung area. Assuming that the exposure time may be 50 per cent greater than the optimum time, such roentgenograms may be obtained with exposures of approximately 1/20 second at 400 ma. at 80 kv. p. and a 6-foot target-film distance. Under these conditions the unsharpness is approximately 0.6 mm.

TABLE V

EFFECT OF TUBE VOLTAGE ON MINIMUM UNSHARPNESS, FOR 16-DEGREE ANODE SLOPE, STATIONARY TARGET, LUNG TISSUE SPEED OF 20 MM. PER SEC., A TARGET-FILM DISTANCE OF 6 FEET, AND AN OBJECT-FILM DISTANCE OF 5 INCHES.

Kv.p.	60	80	100
Optimum exposure time, t_{opt} (sec.)	0.017	0.014	0.012
Milliamperes for t_{opt}	2800	1440	850
Effective focal spot width (mm.) for t_{opt}	13.0	9.5	8.1
Minimum unsharpness (mm.)	1.01	0.84	0.72
$3/2 t_{opt}$ (sec.)	0.025	0.021	0.018
Milliamperes for $3/2 t_{opt}$	1895	950	567
Focal spot width (mm.) for t_{opt}	9.4	7.7	6.6
Total unsharpness for $3/2 t_{opt}$ (mm.)	1.05	0.87	0.75

age. Since, according to equation (6), minimum unsharpness depends upon the energy of the exposure, it will also be affected by the value of the voltage applied to the roentgen tube during the exposure. Assuming that the number of milliamperes-seconds necessary for a chest roentgenogram varies inversely as the cube of the tube voltage, it is possible to calculate the extent to which minimum unsharpness is influenced by the voltage. Table v gives the results obtained for three values of kilovoltage, with a 16-degree stationary target and a lung tissue speed of 20 mm. per second. Table vi gives similar data for a lung tissue speed of 5 mm. per second. It is apparent that a decrease in tube voltage produces a relatively small increase in unsharpness. The increased contrast at the lower kilovoltages may partially, perhaps wholly, compensate for the calculated increase in unsharpness, since it is generally true that increase of contrast improves ap-

TABLE VI

CALCULATIONS FOR 16-DEGREE ANODE SLOPE, STATIONARY TARGET, LUNG TISSUE SPEED OF 5 MM. PER SEC., A TARGET-FILM DISTANCE OF 6 FEET, AND AN OBJECT-FILM DISTANCE OF 4 INCHES.

Kv.p.	60	80	100
Optimum exposure time, t_{opt} (sec.)	0.042	0.035	0.030
Milliamperes for t_{opt}	1150	570	338
Effective focal spot width (mm.) for t_{opt}	7.2	6.0	5.1
Minimum unsharpness (mm.)	0.64	0.53	0.45
$3/2 t_{opt}$ (sec.)	0.064	0.053	0.045
Milliamperes for $3/2 t_{opt}$	740	378	227
Focal spot width (mm.) for t_{opt}	5.9	4.8	4.2
Total unsharpness for $3/2 t_{opt}$ (mm.)	0.67	0.56	0.47

If the contrast provided by 60 kv.p. is desired, the tube current must be nearly 800 ma., and the unsharpness for a 5 mm. per second lung tissue speed increases to about 0.7 mm. If the target-film distance is reduced to 4 feet, the above milliamperage values may be cut in half, with little or no appreciable loss in definition. If definition is to be further improved and the best definition is to be obtained in the faster moving portions of the lungs, the exposure should be synchronized with the phase of minimum movement of the lung tissues and a rotating target tube should be used.

In all the above calculations an object-film distance of 4 inches was used. This was chosen because it probably represents the distance at which the heart produces the maximum movement in the adjacent lung tissue. The exposure time chosen in each case was 50 per cent greater than the optimum exposure time. Such an exposure time gives practically as good definition as the optimum time, permits a one-third reduction in the power required for the exposure, and makes possible a smaller focal spot. The smaller focal spot, in turn, improves the definition in the portions of the lungs farther from the film and in the portions which move more slowly. Therefore, the procedure of applying the Bouwers equation to the object-film distance at which

lung movement is most rapid, and increasing the resulting optimum exposure time by 50 per cent, leads to exposure conditions which tend to give the best average definition over the whole lung field.

In all cases, the selection of an exposure time 50 per cent greater than the optimum time was found to make movement unsharpness about equal to geometric unsharpness. In other words, the best all-round balance between movement unsharpness and geometric unsharpness occurs when both are nearly the same. There is little use in attempting to improve definition in chest roentgenography by shortening the exposure time without also taking steps that will enable a smaller focal spot to withstand the greater power input.

EXPOSURE CONDITIONS FOR AVAILABLE EQUIPMENT

The above considerations indicate the methods affording the best prospects of improvement of sharpness. At the present time, however, all the facilities for achieving these improvements are not generally available. Hence the question is, what exposure conditions should be chosen with existing limitations of equipment to secure the best all-round definition in chest roentgenograms?

Line focus tubes are commonly manufac-

TABLE VII
FOR STATIONARY TARGET OF 20-DEGREE ANODE SLOPE, LUNG TISSUE SPEED OF 5 MM. PER SEC., TARGET-FILM DISTANCE OF 6 FEET, AND OBJECT-FILM DISTANCE OF 4 INCHES.

Kv.p.	1 60	2 70	3 80	4 90	5 100
Milliamperage-seconds.....	47.4	29.8	20	14	10.2
Specific load capacity of focal spot.....	730	730	730	730	730
Optimum exposure time (sec.) t_{opt}	0.046	0.041	0.038	0.035	0.032
Milliamperes for t_{opt}	1030	725	530	400	320
Focal spot width (mm.) for t_{opt}	7.7	7.0	6.4	5.9	5.6
Minimum unsharpness (mm.).....	0.69	0.62	0.57	0.52	0.49
$3/2 t_{opt}$ (sec.).....	0.069	0.062	0.057	0.052	0.049
Milliamperes for $3/2 t_{opt}$	690	480	350	270	210
Focal spot width (mm.) for t_{opt}	6.3	5.7	5.2	4.8	4.5
Total unsharpness for $3/2 t_{opt}$	0.72	0.65	0.59	0.54	0.51

tured with an anode slope of about 20 degrees. In the absence of equipment for synchronizing exposures with the heart cycle, it does not seem desirable to attempt to secure the best possible definition in the more rapidly moving portions of the lungs, but rather to compromise by securing the best definition over the greater portion of

TABLE VIII

THE CONDITIONS 80 KV.P., 20 MA-SEC., 20-DEGREE ANODE SLOPE, 6-FOOT TARGET-FILM DISTANCE, AND 4-INCH OBJECT-FILM DISTANCE, APPLY TO THESE CALCULATIONS.

	Sta- tionary Target	Ro- tating Target
Specific load capacity of focal spot	730	5840
Speed of movement in mm./sec...	5	5
Optimum exposure time (sec.) t_{opt}	0.038	0.019
Milliamperes for t_{opt}	530	1060
Focal spot width (mm.) for t_{opt} ...	6.4	3.2
Minimum unsharpness (mm.)....	0.57	0.28
$3/2 t_{opt}$ (sec.).....	0.057	0.028
Milliamperes for $3/2 t_{opt}$	350	715
Focal spot width (mm.) for $3/2 t_{opt}$	5.2	2.6
Total unsharpness for $3/2 t_{opt}$ (mm.).....	0.59	0.30

the lung area, where the speed of movement apparently does not exceed 5 mm. per second.

The calculations in Table VII are made for a 6-foot target-film distance, but the data for other distances may be readily derived from the tabulated values by making focal spot width proportional to target-film distance and tube current proportional to the square of target-film distance; exposure time should not be changed with target-film distance. The calculations for Table VII are for a stationary target of 20 degrees' anode slope, lung tissue speed of 5 mm. per second, target-film distance of 6 feet, and object-film distance of 4 inches.

Under these conditions, the recommended exposure times vary from 1/20 to 1/14 second, the tube current from 200 to 700

ma., while resultant unsharpness values vary from 0.5 to 0.7 mm., depending on the tube voltage chosen. Sharpness is affected but little by tube voltage, so that the choice of voltage is governed largely by the preference as regards contrast, subject to the limitations in power of the roentgen-ray generating apparatus.

Using shorter exposure times than those of Table VII would produce better definition in the more rapidly moving portions of the lungs, at the sacrifice of definition in the slower portions, and would be desirable only in case it is desired to secure improved sharpness in the lung tissues nearest the heart.

Suppose that the output of the roentgen machine is limited to 100 ma. at the customary roentgenographic voltages. What would be the best chest technique with such a machine? The target-film distance may be reduced to 4 feet with no appreciable loss of definition *as long as the focal spot width is reduced in the same proportion*. The distortion in the single roentgenogram will be increased slightly at the shorter distance whereas the distortion in the stereoscopic image will be lessened. With these changes, adequate exposure for most chests will be given by 80 kv.p., 90 ma., and 1/10 second. Under these conditions, the unsharpness for a lung tissue speed of 5 mm. per second, with a line focus tube, would be 0.74 mm., which is only slightly greater than that given by the conditions recommended for 80 kv.p. in Table VII.

The calculations for rotating target with 20-degree anode slope, a lung tissue speed of 5 mm. per second, 80 kv.p., 6-foot target-film distance, and 4-inch object-film distance in comparison with calculations for a stationary 20-degree target, are recorded in Table VIII. A rotating target tube similar to that specified in this table, but with focal spot 2 mm. in width should be used at a shorter distance, about 4 feet, and the tube current reduced to about 300 ma.

It is of interest to examine the changes in sharpness produced by the successive application of the various factors which im-

prove sharpness, starting with a stationary 45-degree target face, a roentgen machine limited to 100 ma., and an exposure time of 1/10 second, and proceeding, in turn, to a stationary line focus tube, then an increase in the power of the roentgen machine (100 ma. limit removed), an increase of target-film distance from 4 to 6 feet, next the use of a rotating target tube, and, finally, the synchronization of the exposure with the heart cycle. In Table IX, the values

target-film distance from 4 to 6 feet produces no perceptible improvement in sharpness, while the change from a 45-degree to a 20-degree anode slope, and any decrease in exposure time below 1/10 second produce relatively small reductions in total unsharpness.

With the method of exposure synchronization, the exposure technique and focal spot size can be designed to secure the best sharpness in the more rapidly moving por-

TABLE IX

	Stationary Target				Rotating Target	Rotating Target
						Exposure synchronized with heart cycle
Speed of tissue movement (mm./sec.)	5	5	5	5	5	0.62
Anode slope (degrees)	45	20	20	20	20	20
Milliamperes	90	90	154	350	715	180
Kilovolts peak	80	80	80	80	80	80
Target film distance (feet)	4	4	4	6	6	6
Exposure time (sec.)	0.10	0.10	0.058	0.057	0.028	0.113
Unsharpness (mm.)	0.84	0.74	0.60	0.59	0.30	0.15
Percentage reduction in unsharpness		12	19	2	49	50

of total unsharpness produced by these successive changes in technique are calculated for a tube voltage of 80 kv.p. and a speed of lung tissue movement of 5 mm. per second, except in the last computation, where the synchronization is assumed to reduce the speed of movement to 1/8 of 5 mm. or 0.62 mm. per second. After the removal of the 100 ma. limit on the roentgen machine, the target-film distance is increased to 6 feet, the exposure times selected are 50 per cent greater than the optimum time, and the tube currents are those necessary to give adequate exposure in this time. An object-film distance of 4 inches is assumed throughout.

It is apparent from these calculations that the greatest improvements in sharpness are produced by use of the rotating target tube and the synchronization of the exposure with the heart cycle. Increase of

tions of the lungs without noticeable sacrifice of sharpness in the more slowly moving portions. The specifications of column 5 of Table IV appear, therefore, better suited for roentgenography of the whole lung field than those of the last column of Table IX.

GENERAL CONSIDERATIONS

Bouwers* has pointed out that the reduction in exposure made possible by intensifying screens acts to give better definition in chest roentgenography than would be obtained without the use of screens. Under typical conditions of chest roentgenography, intensifying screens reduce exposure by a factor of about 16.* If a chest roentgenogram were made without intensifying screens, the 16-fold increase in exposure would, according to equation (6), multiply

* The intensifying factor may vary considerably, depending upon the hardness of the radiation used for the exposure.

the minimum unsharpness by a factor equal to $\sqrt{16}$ or 2.5. An unsharpness 0.6 mm. obtained with these screens would be increased to 1.5 mm., if the exposure were made on plain roentgen film.

Since the unsharpness obtainable in chest roentgenograms under ordinary conditions is 0.5 mm. or more, the limitations of intensifying screen unsharpness are not particularly important. If an unsharpness of 0.2 mm. or less can be obtained by the use of rotating target tube combined with exposure synchronization, the requirements as regards the definition characteristics of intensifying screens must be more severe.

The quantitative results on exposure times and unsharpness values are based on speeds of lung movement which are known with only a rough degree of approximation. These values of exposure times are doubtless sufficiently reliable for use in routine chest roentgenography with apparatus now in common use. The conclusions from Bouwers' method of analysis regarding the importance of the rotating target tube, and the synchronization of the exposure with the phase of minimum movement of the lung tissue, are valid regardless of the accuracy of the data on speed of lung tissue movement.

To effect future improvements in chest roentgenography, particularly in connection with the method of exposure synchronization, more accurate and more detailed data on lung tissue movements are desirable, such as could be obtained by Ruggles' method of roentgen cinematography. With such data, the results of Bouwers' method

of analysis could be obtained with greater precision, and, furthermore, reliable information on the variations in tissue speed in different portions of the lungs and in various pathological conditions would provide a rational basis for the adaptation of exposure technique to secure the best definition in each individual case, as governed by the speed of movement of the area of principal interest.

SUMMARY

The sharpness of outline of roentgen shadows of the lung tissues is governed chiefly by two factors, the movement of the tissues with the heart beat, and the size of the focal spot of the roentgen tube. The mutual adjustment of these factors to produce the best resultant sharpness may be worked out by the analytical method of Bouwers. The application of this method to chest roentgenography indicates that, in the main, the exposure times giving the best definition or sharpness of lung tissue are in the neighborhood of $1/20$ second. The analysis also shows that the best prospects for marked improvement in sharpness lie in the use of a rotating target line focus roentgen tube, and in the synchronization of the exposure with the phase of minimum lung movement, as proposed by McPhedran and Weyl. The latter procedure has the additional merits of permitting longer exposure times, decreasing the power required of the roentgen machine, and minimizing the distortion in the stereoscopic image caused by movement of the lung tissues between stereoscopic exposures.

REFERENCES

1. BOUWERS, A. A metal x-ray tube with rotating anode. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1929, 40 (Kongressheft), 102-107.
2. BOUWERS, A. The focal spot of an x-ray tube and its load-carrying capacity. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1929, 40, 284-292.
3. BOUWERS, A. On the technic of rapid exposures. *Acta radiol.*, 1931, 12, 175-182.
4. BOUWERS, A. Economy and quality in radiology. *Brit. J. Radiol.*, 1932, 5, 311-323.
5. CHAMBERLAIN, W. E., and DOCK, W. Study of the heart action with the roentgen cinematograph. *Radiology*, 1926, 7, 185-189.
6. MCPHEDRAN, F. M., and WEYL, C. N. Automatic Synchronization of roentgen-ray exposures. *Am. J. M. Sc.*, 1925, 169, 510-516.
7. RUGGLES, H. E. X-ray motion pictures of the thorax (exhibition of film). *Radiology*, 1925, 5, 444.
8. ANDRUS, P. M., and HAMBLETON, A., The capacity of x-ray tubes as influenced by the geometric design of the focal spot. *Radiology*, 1932, 18, 521-531.

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For Program of American Congress of Radiology: See August issue, page 250.

Date of Meeting: September 25-30, 1933.

Place of Meeting: Palmer House, Chicago Ill., Scientific Sessions, Scientific and Commercial Exhibits will all be held in this Hotel.

* For Officers and Standing Committees of the American Roentgen Ray Society and the American Radium Society usually carried on this page, see the April, 1933, number of the Journal.

† Combined meeting of: American Roentgen Ray Society, American Radium Society, American College of Radiology, Radiological Society of North America.

EDITORIALS

INTRAVENOUS UROGRAPHY IN CHILDREN

THE simplification of any method of examination which at the same time obviates the dangers of the examination is always to be sought for in medical practice. Thus the introduction of intravenous pyelography opened up a new field for the study of genitourinary diseases in children. While the cystoscopic examination in association with retrograde pyeloscopy and pyelography in the adult offered one of the greatest advances in diagnostic procedures, this method of examination in children is always fraught with a certain amount of difficulty, both on account of the reactions which are encountered in children, and because of the necessity of employing general anesthesia. Yet there is perhaps no more frequent examination indicated in children than a study of the genitourinary system. That the intravenous method is not as generally employed in children as it should be is evident by the relatively few reports in the literature, though recent reports of Teall,¹ of Schwentker² and of Campbell³ emphasize the importance of this method.

Teall emphasizes its importance by noting the fact that at the Children's Hos-

pital in Birmingham, England, in the two years from 1928 to 1930, only six retrograde pyelographic examinations were made, while during the last two years fifty patients have been investigated by the intravenous method. The simplicity of the technique of the intravenous method of urography in children is sufficient to justify its widespread use, and with the introduction of some of the more recent Bucky grids where the leads are so thin that the faint lines of the grid do not interfere with the diagnostic value of the films the operator is able to shorten the exposure and thereby obtain a more clear cut detailed roentgenogram of the urinary tract.

That the intravenous method of urography in children is definitely satisfactory for diagnosis has been emphasized by Schwentker who made a comparison of the intravenous with the retrograde method. He came to the conclusion that in no instance was the diagnosis made by one method where it could not have been derived independently by the other, and that the results obtained by either route are not always satisfactory at the first attempt. Undoubtedly the simplicity of the intravenous method of urography in children offers an advantage over the retrograde method and its employment should be more widespread than is generally the case.

¹ Teall, C. G. Intravenous urography in children. *Brit. M. J.*, 1932, 2, 788-789.

² Schwentker, F. F. Intravenous urography in children. *Bull. Johns Hopkins Hosp.*, 1932, 51, 318-326.

³ Campbell, M. F. Urography in urinary tract anomalies in infants and children. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 28, 12-21.





From the painting by Eric Haupt, 1931

FREDERICK H. BAETJER

FREDERICK HENRY BAETJER

1874 - 1933

MEMBERS of the American Roentgen Ray Society who attended the Baltimore meeting of 1905 at the Johns Hopkins Hospital will recall to mind without difficulty the active and seemingly omnipresent figure of a gentleman of affable mien and soft speech, as solicitous for the comfort and pleasure of his guests as if, instead, we had been gathered beneath the roof of his ancestral home. Those of us who had not known him previously soon learned that our gracious host was Baetjer—a name ultimately to adorn his profession; a name soon to be heard upon the lips and found within the hearts of his colleagues at home and abroad; a name that now becomes, as a result of courageous persistence, of high purpose and of self totally ignored in the face of another's need, a cherished memory.

Frederick Henry Baetjer was born in Baltimore in 1874, the son of Henry and Frederika (Cronhardt) Baetjer, and died on July 17, 1933. Shortly after his birth his parents removed to Winchester, Virginia, where were passed his young boyhood days. His school-life at the Shenandoah Academy terminated with his entrance to the Johns Hopkins University, where he received the Bachelor's degree in Arts with the class of 1897. He was graduated with the Doctor's degree from the Johns Hopkins Medical School in 1901. In 1903 he married Mary Yarnall Carey, who, with two children, survives him. But eight hours after Baetjer's death a grandchild was born, upon whom rests the honor of bearing his name.

Most interesting is the origin of Doctor Baetjer's devotion to the medical application of x-rays. In the early days of roentgenologic activity at Johns Hopkins, it was customary for the work to be assigned in rotation to one of the house-officers. In due course, this duty fell to

Baetjer and thus, in "looking after the x-ray room," was his enthusiastic interest engendered and his career moulded. Much of the year 1902 was spent in the laboratories of Albers-Schönberg and Immelmann in Hamburg and Berlin. At Johns Hopkins, as elsewhere, the need of a special department for x-ray work was becoming urgent, and on Baetjer's return from abroad he was appointed "Actinographer" to the Hospital, a titular definition not altogether relished by him, but not to be changed until 1915, when the nomenclature now obtaining in this country was formally adopted. He was successively appointed Assistant, Instructor, Associate and Associate Professor, becoming Professor of Roentgenology in 1921.

Doctor Baetjer took a major part in the development of the American Roentgen Ray Society, with which he was prominently connected for so many years. Especially did he cherish the personal contacts it afforded and the friendships that grew out of it; his annual opportunities to renew these associations were curtailed only by recurrences of ill health in him or in his family. His hand was strong in the direction of the policies of the Society, into which he instilled the spirit of his high idealism, thus promoting from concept to principle the now-formulated rule that the practice of roentgenology is based on the expression of opinion evolved from scientific investigation, instead of being a more or less glorified manifestation of the techniques of the photographer's art. Doctor Baetjer was elected President of the Society in 1911 and was its Caldwell Lecturer for the year 1929.

Baetjer's record of service in the World War was notably distinguished. At first, as a Major of the Medical Corps of the Army, he conducted in Baltimore one of the temporary schools of Military Roentgenology;

later he was ordered to the large New York school as Instructor. This post he occupied until all schools were combined at Camp Greenleaf, Fort Oglethorpe, Georgia.

The fabric of his pedagogic methods, especially successful in his University work, was strengthened by the intertexture of his personal charm. He became generally known as a great teacher. In illustration of this was his almost uncanny ability correctly to interpret the objective data of roentgenogram or screen, and it was his joy and delight to deduce and to reconstruct therefrom the *clinical* picture of the case, to the fascination of his colleagues and the inspiration of his students. Aside from his routine teaching, Doctor Baetjer contributed notably to the literature; he did early and important work on thoracic aortic aneurysm and was a pioneer authority on the roentgen-pathology of the bones and joints.

At commemoration exercises held at the Johns Hopkins Hospital in February, 1932, the late Dr. William Sydney Thayer, in presenting to the University a portrait of Doctor Baetjer, said of him:

"Who is more universally loved than Baetjer? A singularly alert and engaging figure, interested in clinical medicine and surgery, he was one of the earliest to devote himself to the applications of the then new roentgenological diagnosis. . . . Endowed by nature with an unusually acute, lucid, logical mind . . . he has become a diagnostician of rare ability, a recognized leader and an unsurpassed teacher in his especial field. . . .

"These diagnostic conferences of Baetjer's are impressive—I had almost said incomparable—demonstrations of the power of acute observation, of orderly, logical reasoning, of sound deduction; they are an inspiration alike to student and colleague."

* * * *

Baetjer's personality radiated an aura of such good cheer, even joviality, that it was difficult to detect beneath it any trace of the momentary vexation that might well assail an ardently enthusiastic spirit under the restraint of physical handicaps. His fortitude made him appear blind to the causes and effects of the operative procedures—totalling over one hundred—that his injuries entailed. Within his visual fields there was only the race to be run over a course of his own plotting, and the tape to be breasted.

His colleagues the world over need no editorial eulogy to deepen their insight into this man's character and life. For them, its strength and its accomplishment are written in terms of hindrances overcome, resistances thrust aside, hazards scorned. In its record they see the allegiance to duty, to ideals and to purpose inherent in the fibre of an American gentleman, physician and soldier consecrated to a life of devotion within the cloisters of his beloved University. As she contemplates her service to Humanity through the mediumship of his loyalty and skill, she may well and proudly perpetuate the memory of one of the greatest of her great Alumni.

PERCY BROWN

SOCIETY PROCEEDINGS CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.

Annual Meeting: Chicago, Ill., Sept. 25-30, 1933.

AMERICAN COLLEGE OF RADIOLOGY

Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.

Annual meeting: Chicago, Ill., Sept. 25-30, 1933.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.

Annual meeting: Cleveland, Ohio, June 11-15, 1934.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.

Annual meeting: Chicago, Ill., Sept. 25-30, 1933.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY

Secretary, Dr. R. T. Taylor, Los Angeles, Calif.

Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.

Annual meeting: Richmond, Va., November, 1933.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N. Y.

Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.

Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. R. G. Willy, 1138 N. Leavitt.

Meets second Thursday of each month October to May inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. H. G. Reinke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. Otto Glasser, Cleveland Clinic.

Meetings are held at 6:30 p.m. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital.

Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.

Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill.

Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. N. Collins, Indianapolis, Ind.

Annual meeting each February 22 in Indianapolis.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Kalamazoo, Mich., October, 1933.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.

Meets first Friday in October, December, February and April. Place of meeting designated by the president.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.

Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 p.m.

NORTH CAROLINA ROENTGEN RAY SOCIETY

Secretary, Dr. Major Fleming, Rocky Mount, N.C.

Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. H. S. Bull, 604 Masonic Temple, Auburn, N. Y.

Three meetings a year—January, May and November.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Reiley, Clearfield, Penna.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. Karl Kornblum, Graduate Hospital.

Meeting first Thursday of each month from October to May inclusive, at 8:15 p.m., in Thompson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. W. W. Fray, Strong Memorial Hospital.

Meets monthly on second Thursday from October, 1932, to May, 1933 inclusive, at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB

Secretary, Dr. W. K. Mueller, University Club Bldg.

Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston.

Meets at time and place of South Carolina State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.

Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY

Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

VIRGINIA ROENTGEN RAY CLUB

Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.

Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGÍA Y FISIOTERAPIA

Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba.

Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.

Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

INDIAN RADIOLOGICAL ASSOCIATION

Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta. Meets annually in January, and at such places and times as the Council may appoint.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY

Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgian).

Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE

Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.

Secretary for German language, Dr. Scheurer, Molzgasse, Biel.

Meets annually in different cities.

SOCIÉTÉ FRANÇAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE

Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA

Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)

Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.

Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY

Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETÀ ITALIANA RADIOLOGIA MEDICA

Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banul Maracine 30 Bucarest, Rumania.

Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson.

Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin.

Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY.

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.

Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. B. Kryński, 11 Zielna St.

Meets once a month except in the summer time.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN

Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY

Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK

Secretary, Dr. H. Scheuermann, Copenhagen.

Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND

Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY

Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION

c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY

Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan. Meets bi-monthly on third Sunday.

EXHIBIT OF PICTORIAL PHOTOGRAPHY

In the January (1933) number of the *AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY* there appeared a letter, written by Dr. A. U. Desjardins, Rochester, Minnesota, in which he attracted attention to the fact that, next to physics and electrical engineering, knowledge of photography is the most valuable asset to the roentgenologist, and in which he stressed the desirability of photography as a hobby. Many members of the American College of Radiology, the American Roentgen Ray Society, the Radiological Society of North America, and the American Radium Society have long been interested in photography, and the interest of those who practice diagnostic roentgenology is nearly always reflected in the technical quality of their roentgenograms and the accuracy of their interpretations. In this letter was also advanced the idea of organizing an exhibit of pictorial photography in connection with The Congress of Radiology, which is to be held at the Palmer House, Chicago, September 25 to September 30.

The publication of this letter brought forth a sufficient number of replies to indicate considerable interest, and steps toward the organization of such an exhibit were taken. In this exhibit strictly medical photography will have no part; only general pictorial photography (landscape, portrait or genre) will be included. A committee consisting of Dr. C. D. Enfield, Louisville, Kentucky, Dr. E. A. Merritt, Washington, D. C., and Dr. A. U. Desjardins, Rochester, Minnesota, was organized. Also, a committee of three judges, consisting of Dr. F. W. Burcky, Evanston, Illinois, Dr. Max Thorek, Chicago, Illinois, and Mr. G. H. High, Chicago Camera Club, Chicago, Illinois, has been appointed to pass on the individual exhibits and determine the two contributors who deserve the first and second prizes. The Eastman Kodak Company has graciously offered, as a first prize, a Kodak Recomar #33, which is

equipped with an f. 4.5 Anastigmat lens, Compur shutter, 3 single plate holders and film sheaths, film pack adapter, exposure table and brown cowhide carrying case to hold camera, plate holders and film pack adapter. As a second prize, they offer a Kodak Six-16, which is equipped with an f.6.3 lens, with a Diodak shutter.

The space reserved for the exhibit is naturally limited, and already nine members of the various societies taking part in the Congress have undertaken to contribute to this exhibit.

Under different circumstances, it would have been advisable to conduct this exhibit strictly according to salon rules, but inasmuch as the object of this first exhibit is to stimulate interest in the photographic side of roentgenology by leading as many roentgenologists as possible to take up photography as a hobby, it was been thought best to allow some latitude. Therefore, the contributors will be allowed to mount, mat or frame their prints according to their own taste.

If this first exhibit should prove as successful as it now promises to be, and if it should stimulate sufficient interest, future exhibits should be conducted according to salon rules.

A. U. DESJARDINS
Chairman

In connection with the above announcement of an exhibit of pictorial photography at the American Congress of Radiology, the following item taken from the *New York Times*, July 27, 1933, would seem of interest:

THE FIRST PHOTOGRAPHER

The little town of Chalon-sur-Saône has settled down to normal life after having paraded around the statue of JOSEPH NICEPHORE NIEPCE in its public square and crowded into the unpretentious museum where a few relics of his inventive activity are preserved. For NIEPCE, who shares with DAGUERRE the honor of having discovered photography, died a hundred years ago in near-by Gras. Probably the

hundred million amateur photographers who press bulbs all over the world are unaware of their debt to him. Out of his simple process of making pictures on metal plates coated with asphaltum came both photo-engraving and the enormous industry of manufacturing lenses, roll films and paper for men and women to whom a camera has become an ordinary utensil.

Who has not seen linen bleached by the sun and posters fading on fences? Observation thus simple started WEDGWOOD on his experiments and inspired NIEPCE. The wonder is that out of it DAGUERRE, NIEPCE's partner, could devise the process of developing and fixing an image formed by a lens. These men were not chemists but empiricists, who floundered not in darkness but in dazzling sunlight. It is admirable to follow a program based on a definite theory, as does a modern research scientist, but there is something more romantic about these two, depending more on brilliant intuitions than on strict reasoning in quest of a process which would take the place of the artist and the engraver. If ever a discovery was made as the result of sheer imagination and unflagging industry it was that of photography.

Yet it is to formal research that the final victory has come—if final can ever be used in speaking of any scientific inquiry. Ultra-violet regions, infra-red rays of the spectrum—of these NIEPCE and DAGUERRE knew little if anything. To photograph by light to which we are blind, to look at the world with a lens that sees only infra-red—we are still astonished at the feat. These are the natural consequences of that research in organic chemistry which has given us extraordinary ray filters and dyes. Out of NIEPCE's work in preparing pictures which could be printed like a lithograph, out of DAGUERRE's process of developing and fixing an image came photochemistry and then photosynthesis. Between the emulsion that transcribes a smile and the plant that with the aid of sunlight builds up green foliage, there is a kinship still to be discovered. For the rays with which NIEPCE and DAGUERRE only toyed, as it seems to us now, are the rays of life itself.

ERRORS IN DIAGNOSIS OF FREE PLEURAL EFFUSIONS

To the Editor:

I have just read with considerable interest the case report entitled "An Unusual Case of Pleural Effusion Simulating Eleva-

tion of the Diaphragm" by Drs. Yater and Rodis which appeared in the June, 1933, number of the Journal. In this connection I am constrained to call attention to two papers which I published in 1931. The first entitled "Roentgen Diagnosis of Small Pleural Effusions" appearing in the *Journal of the American Medical Association*, Vol. 96, page 104, contains illustrations (Fig. 1) of a case exactly similar in its roentgen manifestations to that reported by Yater and Rodis. In the caption the resemblance of the fluid to a high diaphragm is noted and the change in appearance with the patient supine is also shown. The second article entitled "Roentgenologic Observations on the Movement of Pleural Effusions" appeared in Vol. 25, page 220, of this Journal. In Figure 5 a somewhat similar case is illustrated. I have observed several others of this type in addition.

I call attention to these two papers particularly because in both of these the fact that free pleural effusions may move freely in the pleural cavity and may take on most unorthodox positions is emphasized. From my observation the phenomenon reported by Yater and Rodis is not surprising. The explanation, I believe, lies in a change in the elasticity of the lung underlying the fluid. The ordinary textbook conception of a pleural effusion distributing itself in an S-shaped curve along the periphery of the chest occurs principally in those cases wherein the normal elasticity of the lung and hence the negative pressure in the pleural cavity has been preserved. If that elasticity is interfered with for any reason or the negative intrapleural pressure changed the roentgen appearance of the fluid will take on a different form. This is true in many cases of cardiac decompensation particularly, but will also occur in other conditions.

It should be emphasized that the textbook descriptions of the roentgen appearance of pleural effusions apply only to a certain percentage of the cases. I have recently observed some cases, which will be reported in detail later, in which a free

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

RECENT ADVANCES IN RADIUM. By W. Roy Ward, M.B., B.S., M.R.C.S., Medical Director and Surgeon to the Radium Institute, London, and A. J. Burden Smith, M.B., B.S., M.R.C.S., Surgeon to the Radium Institute, London. Cloth. Price, \$5.00. Pp. 324, with 4 colored plates and 140 black and white illustrations. Philadelphia: P. Blakiston's Son & Co., Inc., 1933.

This small volume from the Radium Institute in London contains a well balanced, brief survey of radium therapy, as it is being carried on in the better clinics of England, Sweden, Belgium, France, and the United States. A spirit of fairness is in evidence throughout the book and the authors state that, "It is of the highest importance that the medical practitioner should realize where radium can help, where supersede and where hinder the surgeon."

A relatively small section covering 83 pages deals with general topics such as physics, action of radiation, radiosensitivity, dosage, radium apparatus, protective measures and mass radiation. Some of the best theories explaining the effect of radiation on living tissue are elaborated and a large rôle is delegated to vascular damage as the primary factor in the resolution of malignant tumors. The grading of neoplasms is clearly explained with the aid of excellent photomicrographs. Heavily filtered, platinum needles having a low radium element content and designed for implantations lasting seven or eight days are described. Although radon is recommended, gold or platinum seeds having a wall thickness of 0.5 mm. are utilized in most accessible locations. Mass radiation at a distance is designated as a most hopeful field and the types of apparatus used in the various radium clinics are carefully described.

The remainder of the book is devoted entirely to clinical problems but is subdivided into sections dealing with malignant and non-malignant conditions. In the malignant division separate chapters deal with the breast, the uterus, the tongue, the inside of the mouth, jaws and antrum; the larynx, pharynx, and esophagus; the rectum and anal canal; the skin, penis and

vulva; the bladder and prostate; the eye and sarcoma. In a general way an attempt is made to discuss the anatomy, pathology, symptomatology, surgery, radium technique, prognosis and results applicable to neoplasms in each part of the body, and where several radium techniques are recognized they are all described and their good points emphasized. The Radium Institute utilizes, for the most part, a combination of weak, heavily filtered, interstitial sources and heavily filtered surface radiation delivered by multiple sources held at a distance of a few centimeters from the skin. Many drawings and photographs illustrate the good results obtained in individual cases and a fair number of statistical tables covering end-results are included. Many special pieces of apparatus, such as a seed gun, a cystoscopic implanter, etc., are illustrated.

The last twenty-nine pages deal rather sketchily with uterine hemorrhage, the various types of adenopathy and a few skin diseases. Although the material given in this section is of good quality, the subjects are so inadequately covered that the reader reaches the end of the book with the feeling that it might better have been omitted. However, the volume, as a whole, is well arranged and very readable and it can be freely recommended as one of the best reviews of the world's knowledge of radium therapy for malignant tumors now available.

CHARLES L. MARTIN

ROENTGENOGRAPHIC STUDIES OF THE URINARY SYSTEM. By William E. Lower, M.D., F.A.C.S., Chief of Department of Urology, Cleveland Clinic, Former Associate Professor of Genitourinary Surgery, Western Reserve University, Surgeon to Cleveland Clinic Hospital, and Bernard H. Nichols, M.D., F.A.C.R., Chief of Department of Roentgenology, Cleveland Clinic, Cleveland, Ohio. Cloth. Price, \$16.00. Pp. 812, with 812 illustrations. St. Louis: The C. V. Mosby Company, 1933.

This work of Lower and Nichols is confined rather closely to the roentgenologic aspects of

urology. A relatively small part of the volume is devoted to the technique of urethrography, cystography, ureterography and pyelography, including the intravenous method. There is a brief discussion of the pathology of the urinary tract, limited to such conditions as are actually demonstrable roentgenologically. The authors insist that only such findings should be included in the roentgen diagnosis, the final diagnosis being in the province of the urologist. There is also a brief chapter dealing with indications for a roentgenographic examination of the right upper abdominal quadrant for conditions which may be related to, or confused with, urinary conditions. Nearly 90 per cent of the book is devoted to roentgenograms. There are 442 cases from the authors' practice, many with several illustrations. Each roentgenogram is accompanied by a small schematic drawing to bring out essential details that might be obscured in reproduction. With each case is a brief outline, first of roentgenographic findings, then of the history with clinical and laboratory findings and the diagnosis. The cases are varied and include patients with both usual and rare pathological conditions.

This book is valuable as a reference work and a careful study should give one an excellent foundation for roentgenologic urology. We recommend it because of its large store of valuable material, the excellence of its illustrations and the conciseness and completeness with which cases are handled.

E. W. HALL

HANDBUCH DER RONTGENDIAGNOSTIK UND -THERAPIE IM KINDESALTER. Unter Mitwirkung von Fachgenossen. Herausgegeben von Prof. Dr. St. Engel, Leiter der Kinderklinik der Städt. Krankenanstalten, Dortmund, und Dr. L. Schall, Leiter der Kinderabteilung des Landeskrankenhauses, Homburg-Saar. Paper, price M. 72.00; bound, M. 75.00. Pp. 720, with 637 illustrations. Leipzig: Georg Thieme, 1933.

In producing a work upon so difficult a subject as diseases of childhood, St. Engel and Schall have not relied solely on their own knowledge but have enlisted the aid of special-

ists from numerous clinics, each separate branch of the subject being discussed by one exceptionally qualified in his specialty. The result is an excellent compilation of knowledge concerning roentgen diagnosis and therapy. The authors have carefully arranged the material so as to cover the entire field in a systematic manner.

The normal skeletal system is dealt with in a chapter on epiphyseal development and ossification centers. The diseases of the skeletal system are considered under three headings: (1) Primary disturbances in growth such as chondrodystrophies, osteopsathyroses or brittle bones, cretinism, mongolianism, etc. (2) Secondary disturbances in growth such as rachitis, scorbutus, osteitis fibrosa, Gaucher's disease, etc. (3) Inflammatory diseases such as lues, tuberculosis and osteomyelitis. These are discussed both in general and in detail and all are generously illustrated.

The diseases of the intrathoracic structures are presented in a very complete and satisfactory manner and many interesting roentgenograms are reproduced. The divisions of gastroenterology and urology are briefly considered and there are special chapters on the skull with intracranial lesions and pneumography. Nearly one-third of the volume is devoted to roentgen and radium therapy of diseases of childhood. These include tuberculosis, blood and lymph diseases, disturbances of glands of internal secretion, hypertrophies, as of tonsils and adenoids, infectious diseases and neoplasms. The special application of roentgen and radium rays to these conditions in children being even more obscure, generally speaking, than the diagnostic features of childhood diseases, this group of articles should be of considerable aid to the roentgenologist. A chapter on ultraviolet therapy and vitamin D is appended to the volume because of their general interest to radiologists and pediatricians.

For the sake of completeness the editors have included chapters on the physics of the roentgen ray. In view of the many existing volumes on physics and technique it seems unnecessary that space should be given to these subjects in a clinical work of this nature.

E. W. HALL

DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., 105 Rutledge Ave., Charleston, S. C.

A SIMPLE TECHNIQUE FOR ROENTGEN EXAMINATION OF THE PETROUS PYRAMID

By MARCY L. SUSSMAN, M.D.

Mt. Sinai Hospital (Service of Dr. Leopold Jaches)

NEW YORK CITY

IN THE roentgen examination of the petrous pyramids, the view which theoretically should be of most use is that which presents these structures with least distortion and practically, it is the view which represents the pyramid as we see it when looking from the front, perpendicular to its long axis. The view is given by Stenvers' projection. Köhler¹ describes this as follows:

The patient rests prone, the head turned about 45° towards the sound side, with the nose, forehead and the zygoma of the affected side towards the plate. The central ray passes in a plane perpendicular to the horizontal through the mid-point of a line uniting the external auditory meatus with the outer margin of the orbit, which plane forms an angle of 45° with the sagittal line. It is directed from the region of the external occipital protuberance to this point and forms with the horizontal a dorso-caudal open angle of 12° .

Where relatively few such examinations were made, difficulty has often been encountered in properly positioning the patient and in accurately centering the central ray. It was also particularly difficult to obtain comparable views of both sides. The excellent apparatus that Pfeiffer² has devised for roentgenography of the optic foramina lends itself to modification for the roentgen examination of the petrous pyramids.

The cassette holders are placed at 45° to the horizontal instead of 37° in the Pfeiffer apparatus—the forehead rest becomes a

chin rest, the forehead and nose actually resting in the angle—the chin end of the apparatus is raised so that the inclination of the apparatus is 12° to the horizontal. It is now merely necessary to change the center points of the cassettes and the apparatus is made available for the desired use. The center points are placed at the level of the center of the petrous pyramids, i.e., at the external auditory meatus, found to be approximately $5\frac{1}{2}$ " above the apex of the 90° angle in most of our patients.

We have found it necessary to center the tube by means of an adjustable pointer which fits into the tube holder in place of a cone and is at right angles to the plane of the tube. The tube is placed at the vertical working distance (we use 27" with a General Electric XP 1 tube) and tilted at 45° to the horizontal. The pointer and the lateral distance of the tube are adjusted until the pointer touches the center mark of one cassette holder. With the apparatus remaining in position, the tube is moved an equal distance to the other side of the midline of the apparatus and the tube is tilted 45° toward the opposite cassette. The pointer should now be touching the center point of this cassette. If then the position of the apparatus is marked out on the table and the lateral distances of the tube be marked (the vertical height is kept constant) conditions can always be duplicated, the central ray will always point at the external auditory meatus on either side. A small cone is then substituted for the pointer. We believe the pointer is a neces-

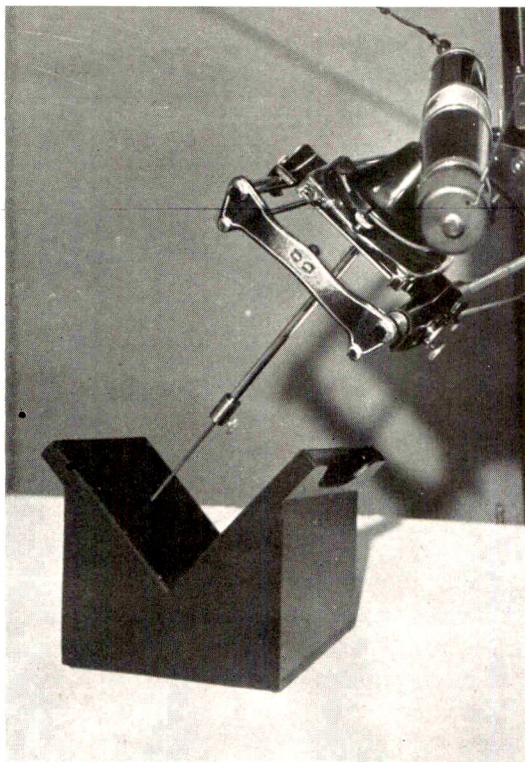


FIG. 1. Photograph of apparatus showing method of centering tube. The chin end of the apparatus is elevated 12° above the forehead end.

sary adjunct since with the 12° tilt of the apparatus, lining the central ray up by eye is difficult and apt to lead to disappointment—either the cone may cut off part of the petrous pyramid or the petrous pyramid may be projected so as to overlap the occipital bone.

We have often made two exposures of each side, one lighter and one heavier exposure, since we have found the position excellent for demonstration of tip and cortical cells of the mastoid process where this is desired. This requires considerably less exposure than does the demonstration of the petrous pyramid itself.

Depending upon the type of case, we also find the following views desirable for complete roentgen examination of the mastoid processes and petrous pyramids:

- (1) The usual Law position for the mastoids.
- (2) A posteroanterior view of the skull,

the central ray being in the same plane as that through the outer canthus of the eye and the external auditory meatus. This is made with the aid of a Potter-Bucky diaphragm. The petrous pyramids are projected, foreshortened, into the orbits.

(3) Stereoscopic anteroposterior views of the skull. The patient lies upon the table on the back, with the chin touching the chest. In the first exposure, the central ray passes from above the head through the base of the skull at an angle of 50° to the horizontal. The adjustable pointer has been found to be very useful for "lining up" in this examination also. The second exposure is made with the tube shifted the necessary stereoscopic distance farther away from the head and tilted more, as much as is necessary to have the ray again pass through the base of the skull. This examination is also

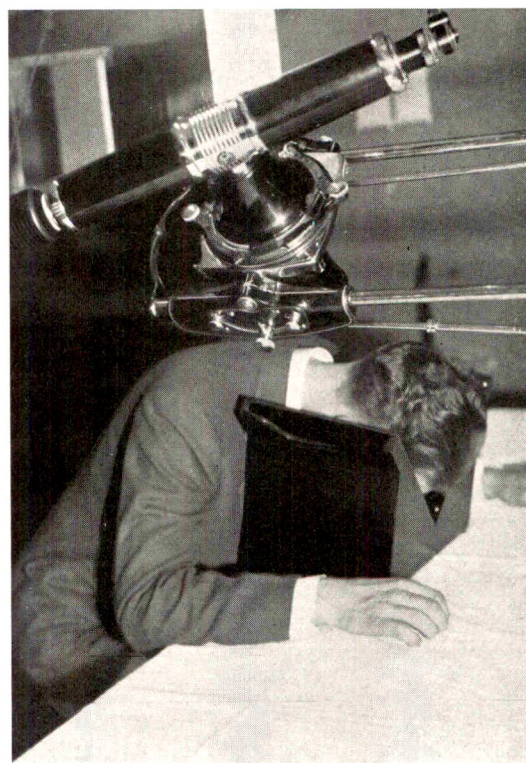


FIG. 2. The pointer has been replaced by a cone. The patient is in position, the forehead and nose touching the angle, the chin lifted as much as is necessary. The external auditory meatus is adjusted to the center line.

made with the aid of a Potter-Bucky diaphragm. The petrous pyramids are, in these views, projected above the orbits and the base of the skull, into what is practically a "top" view. The second view gives about the same result as Mayer's projection.¹

It is not the purpose of the present discussion to present the indications for roent-

number of uses for the 45° angle (for example, in studies of the zygoma) to justify a separate apparatus.

A further possible future modification is suggested. It would be easily possible to cut holes in the wooden framework supporting the cassettes or replace the wood by glass in such a way as to make it possible to

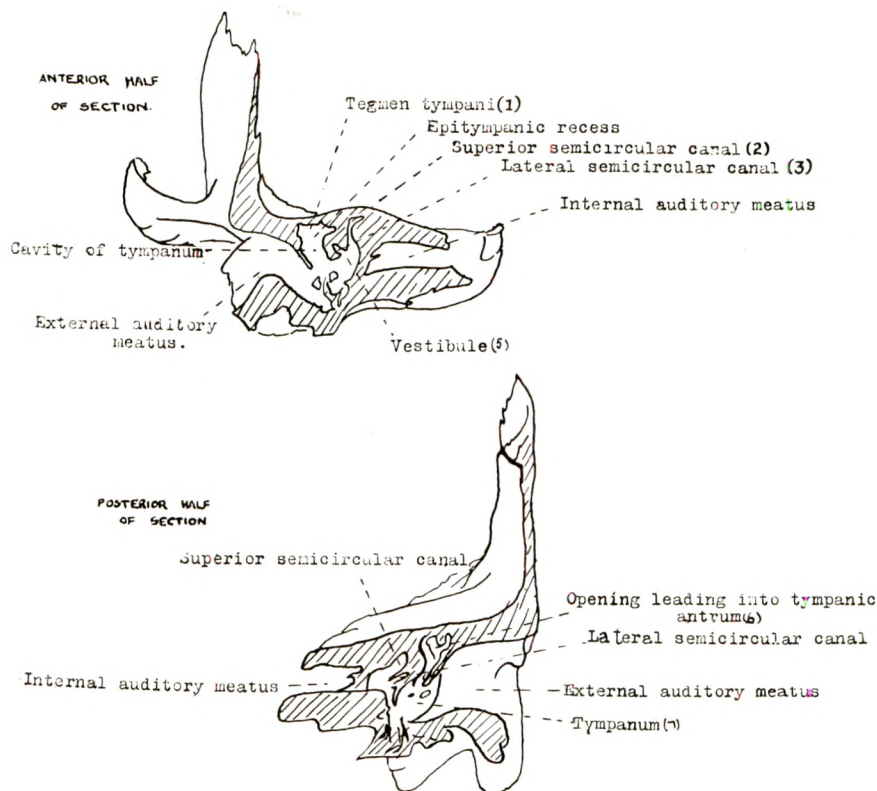


FIG. 3. Vertical transverse section through temporal bone (after Cunningham).

gen examination of the petrous pyramids nor to present cases illustrating disease of these structures. The apparatus has been described because it has simplified the technique of examination to the same degree that Pfeiffer has simplified roentgenography of the optic foramina. The illustrations, it is hoped, will sufficiently define the information to be obtained from the various views. It is possible to combine both pieces of apparatus by means of properly placed hinges. This, however, makes it somewhat too complicated for routine use in a clinic and we have found a sufficient

place the part of the head to be examined exactly at the center line of the cassette or to establish new center lines for other structures which are to be examined and for which the 45° angle is necessary. These changes may, of course, be made as the need arises.

SUMMARY

An apparatus is described for making simple exposures of the petrous pyramids in the Stenvers projection. Several other views are described all of which should be taken for a complete examination of these

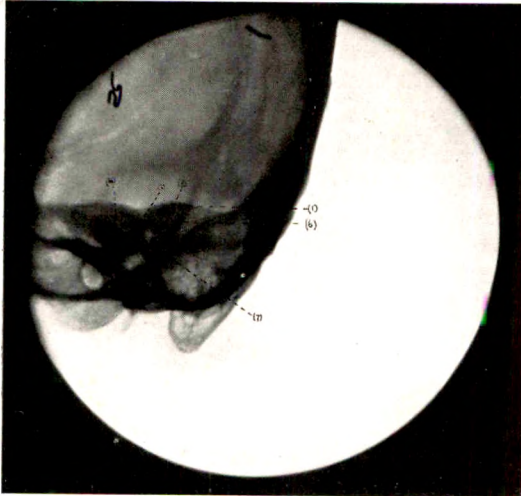


FIG. 4. Roentgenogram of anatomical specimen in the Stenvers position.

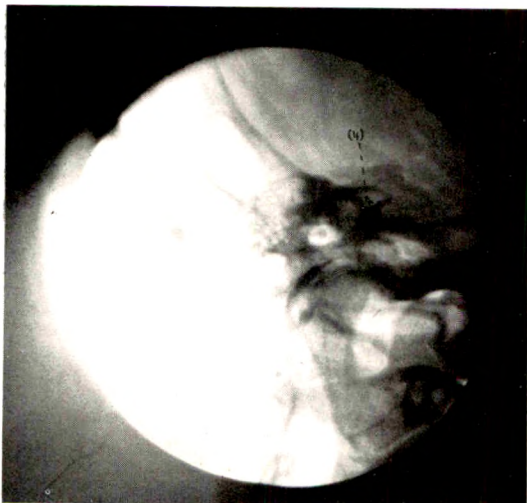


FIG. 5. Roentgenogram of the petrous pyramid in the Stenvers position. Less exposure is necessary in order to bring out the cortical and tip cells of the mastoid process.



FIG. 6. Roentgenogram showing a "top" or Mayer's position of the petrous pyramid.

structures. Information in regard to the mastoid process, antrum, tympanic ossicles, labyrinth, internal auditory meatus and middle fossa of the skull is thus made available. It should be possible to apply this complete examination in all cases of suspected inflammations, traumas and tumors involving the petrous bone.

REFERENCES

1. KÖHLER, A. Röntgenology. Translated by Arthur Turnbull. William Wood & Co., New York, 1929.
2. PFEIFFER, R. L. A new technique for roentgenography of the optic canals. AM. J. ROENTGENOL. & RAD. THERAPY, March, 1933, 29, 410-415.



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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

YATER, W. M., COE, F. O., and RODIS, ISADORE. The treatment of essential hypertension by x-radiation of the medulla oblongata. *South. M. J.*, July, 1932, 25, 730-733.

An experimental series of roentgen treatments over the medulla oblongata in patients with essential hypertension was carried out in the hope of obtaining a fall in the blood pressure. The experiment was based upon the concept that hypertension is the result of excessive stimulation of the vasomotor center, thought to be located in the fourth ventricle floor. If this center could be made less irritable, it would not respond as readily to this frequent stimulation. The authors hoped that roentgen irradiation over the site of this center might result in a raising of the threshold of excitability without injury to the numerous and delicate nerve elements in the medulla.

Eight patients received three treatments in the suboccipital region at intervals of two weeks with the following factors: 200 kv.p., 5 ma., 0.5 mm. copper and 1.0 mm. aluminum, 60 cm. for 40 minutes to an area approximately 5 cm. square, a dosage of 1,020 r within four weeks.

The patients were observed for an average of six months, without evidencing any noteworthy symptoms referable to the irradiation. Blood pressure readings were made at weekly intervals, all medication was withheld and the patients instructed to carry on their usual activities.

In 7 of the 8 cases, there was a possible effect of the irradiation upon the height of the blood pressure, manifesting itself as a tendency to lower levels. At the end of the period of observation, however, all the patients still had hypertension.

The dosage employed was greatly in excess of that used by others in the treatment of nerve ganglia for painful affections. The observations of the authors are reported to stimulate interest in this form of treatment, even though the results are not particularly encouraging. They

plan to continue the experiment with larger doses from several portals of entry on patients in the fluctuating stage of hypertension, who have been carefully observed through a control period, since all patients in this series were in the fixed stage of hypertension with probable permanent organic changes in the walls of the arterioles when no treatment is of particular value.—*W. R. Brooksher, Jr.*

BRÜNAUER, STEFAN R. Indikationen zur Röntgentherapie bei Hautkrankheiten. (Indications for roentgen therapy in skin diseases.) *Strahlentherapie*, 1932, 43, 601-630.

After discussing the theoretical bases for the use of roentgen rays in skin diseases, the author takes up some of the manifold indications for irradiation in dermatology, calling attention to the fact that no more than the absolutely necessary amount for the desired purpose should be given, as the total dose of rays that the skin can tolerate in a lifetime is limited and any later irradiation may be rendered impossible or dangerous.

There is a group of skin diseases in which roentgen irradiation is particularly indicated, including the leucemic diseases, mycosis fungoides and lymphogranulomatosis. Roentgen rays have an elective action on the leucocyte-producing organs. While irradiation has an excellent effect in these diseases it does not prevent the ultimate fatal outcome.

Irradiation is indicated in subacute and chronic eczema and neurodermatitis. Medical treatment should be tried first in acute eczema. Good results have been obtained in psoriasis by irradiation of the thymus and other endocrine glands. Lichen ruber planus has been treated successfully by a combination of roentgen rays and arsenic. Roentgen irradiation is of value in epilation for parasitic diseases of the scalp but there is some danger connected with its use on the face as the skin and salivary glands may be injured.

Roentgen irradiation is indicated only in the indurated and phlegmonous forms of acne vulgaris. In acne rosacea the results are not uniform. While in the group of keratoses a number of affections respond well to irradiation, such

as warts and plantar hyperkeratoses, others such as ichthyosis, palmar and plantar hereditary keratoma and Darier's disease are refractory.

The effects of irradiation are good in pyogenic processes, such as carbuncle and furuncle where they seem not only to have a local action but also to bring about immunity. Fried also recommends the roentgen treatment of phlegmon and erysipelas. Roentgen therapy is indicated in some forms of skin tuberculosis but because of the tendency to recurrence in lupus vulgaris, irradiation is apt to be repeated too often and injure the skin. Finsen light is therefore to be preferred. Roentgen irradiation gives excellent results in lupus follicularis disseminatus, scrofuloderma and tuberculosis verrucosa cutis. The results are uncertain in Boeck's sarcoid and erythema induratum. The results of roentgen treatment are good in actinomycosis, more particularly the cervico-facial form than the thoraco-pulmonary or intestinal form. Oral administration of potassium iodide seems to sensitize to the rays.

Roentgen irradiation is used in many forms of pruritus to control the itching. This is also its chief effect in Dühring's dermatitis herpetiformis. Pain can be controlled in the multiple forms of dermatomyoma by roentgen irradiation and the tumors also reduced in size. Roentgen therapy combined with electrocoagulation has proved valuable in the small fibromatous tumors of Recklinghausen's disease. Radium is better than roentgen irradiation for keloids, lymphomas and hemangiomas. Cavernous angiomas respond well to roentgen, radium or grenz rays. The more cavernous these tumors are the better they respond to irradiation. Plane birth marks are very little affected as they develop in intrauterine life and their radiosensitiveness is exhausted. Sarcoma multiplex hemorrhagicum reacts well to roentgen irradiation but the results are generally only symptomatic. A variety of treatments may be used in the various forms of skin cancer, including electrocoagulation, surgery and irradiation. Various forms of scleroderma are favorably affected by irradiation, either local or of the spinal column. Irradiation of the spinal column has also proved successful in sclerema neonatorum.

The fact that roentgen irradiation so frequently has to be combined with other methods in skin diseases does not lessen its value. The

skill of the dermatologist is often shown in knowing how to select and combine different remedies.—*Andrey G. Morgan.*

TAUSSIG, LAURENCE, and MORROW, HOWARD. Epithelioma of the skin. *Radiology*, Dec., 1931, 17, 1281-1286.

The diagnostic features of these lesions are discussed. The type of therapy employed depends on the individual lesions. Treatment by means of radiotherapy should aim at giving an adequate dose at the beginning of treatment. In lesions where the least amount of destruction possible is indicated, radium alone is given preference over roentgen rays. Where there are no contraindications the authors prefer to curette the lesions and cauterize the base. This is followed, particularly in squamous cell lesions, by the application of radon tubes. Lesions previously subjected to unsuccessful irradiation are treated by means of radical surgery. Regional lymph nodes are not removed unless clinically involved. Operation should include the entire lymph chain; prophylactic irradiation of lymph chains is of questionable value. If inoperable, involved nodes are treated by means of gold emanation seeds.—*E. I. L. Cilley.*

SCHTEINGART, MARIO. Le goitre exophthalmique; (étude clinique et anatomique). (Exophthalmic goiter; clinical and anatomic study.) *Rev. sud.-am. de méd. et de chir.*, Nov., 1931, 2, 1073-1110.

This article represents a detailed study of the clinical, biochemical, anatomic and therapeutic aspects of exophthalmic goiter on the basis of 250 cases personally observed. The procedure of treatment is summarized as follows: Two methods are used: (1) the radiotherapeutic method combined with administration of iodine and (2) the surgical method combined with iodine both in the preoperative and postoperative periods. The patient is first placed in an absolute physical and mental rest, on a high caloric diet, and on 30 drops of iodine daily. After fifteen to thirty days, radiation therapy is instituted or surgery is resorted to, depending on the general condition of the patient and the circumstances. Generally surgery is preferred to radiation. The results obtained were 70 per cent amelioration in roentgen therapy associated with iodine, 50 per cent in roentgen therapy alone, and 80 per cent after surgical intervention.—*T. Leucutia.*

SCHREINER, BERNARD F. Tumors of the male breast, based on a study of thirty-one cases. *Radiology*, Jan., 1932, 18, 90-92.

During the years 1914 to 1931 (June), 17,486 cases were admitted to the author's tumor clinic. Included in this number were 1,664 cases of disease of the breast, 31 of which occurred in males. From this series it is concluded, (1) that carcinoma of the male breast constitutes about 1.25 per cent of all cancers of the breast; (2) carcinoma of the male breast is an uncommon disease; (3) sarcoma is rare; (4) carcinoma of the male breast is as malignant as carcinoma of the female breast and occurs, as a rule, late in life.—*Ellsworth Johnson*.

SOILAND, ALBERT. The management of breast cancer. *J. Am. M. Ass.*, March 5, 1932, 98, 786-788.

Radiation therapy has advanced to such an extent that some surgeons are abandoning surgery in favor of radium therapy. Implantation of needles with heavy platinum filtration offers more favorable results than with the formerly used lightly filtered needles, and avoids the extensive sloughing so often obtained with the older methods.

Implantation is not easy, and bears every aspect of a major operation requiring skill and care. One hour or more is usually consumed in carefully implanting the needles in one, two, or three circles about the involved tissue, being sure that all areas of possible involvement are covered and that the needles are not within 1 cm. of bone and periosteum. Axillary and clavicular regions are included. Fifty or more needles are necessary, and 75 to 100 mg. of radium are used over a period of seven to ten days. Patients are confined to bed during treatment and usually suffer little discomfort. Precaution against radiation sickness should include alkalization and bland diet.

The chief problem to be met is obtaining sufficient radium in the costly form of platinum needles.—*E. W. Hall*.

KEYNES, GEOFFREY. The radium treatment of carcinoma of the breast. *Brit. J. Surg.*, Jan., 1932, 19, 415-480.

This comprehensive article covering 65 pages details the evolution during a ten-year period of the radium element needle technique now used at St. Bartholomew's Hospital in London,

in the treatment of cancer of the breast. The needles are made of platinum, have wall thicknesses of 0.5 and 0.6 mm. and are of two lengths. The longer ones used in the breast and axilla have an active length of 5.0 cm. and contain 3.0 mg. of radium, whereas the shorter ones, used in the infra- and supraclavicular spaces and the intercostal spaces along the sternum, have an active length of 3.2 cm. and contain 2.0 mg. of radium. The needles are inserted into the breast so as to surround the tumor but not pass into it and so as to irradiate all of the breast tissue and its lymphatic channels. An attempt is made to place the needles parallel to one another at 1.5 cm. intervals in the breast and over the pectoralis major, and in a cone-shaped pattern in the axilla with the apex in the upper part of the space. Implantations are also made above and below the clavicle and in the intercostal spaces. The radium is usually left in place for seven days.

Many case histories and photographs of histologically proved cases are given. Small tumors frequently disappeared in five or six weeks, and marked regression was observed in more advanced conditions. Metastatic glands appeared to respond to the treatment as well as the primary tumors. In 18 cases small masses remaining in the breast after treatment were removed surgically and examined under the microscope. In 7, no evidence of cancer could be made out, while in the others small nests of malignant tissue remained in the fibrosis. In one patient pregnancy occurred two months after the treatment was carried out. Following delivery, normal lactation occurred in the treated breast and the woman has remained well for three years and ten months.

In a small number of patients, recurrences were noted in the breast or axilla but the author believes these mishaps were due to improper implantation patterns which left some of the lymphatic areas untreated. A few necroses occurred where too many needles were inserted in a small area. A study was made of one group of cases in which implantations were done following both conservative and radical removals of the breast.

A table including the main points observed in 171 cases is attached to the article. A statistical study made by Dr. Janet E. Forber, covering patients alive at the end of three years, is most interesting. There were 9 operable, 11 operable with glandular involvement, and 26

inoperable cases included; 77.7 per cent of the first group, 36.3 per cent of the second group, and 46.1 per cent of the third group were alive at the end of three years.—*C. L. Martin.*

SCHMITZ, HENRY. Technic in pelvic irradiation. *Radiology*, Dec., 1931, 17, 1230-1242.

The author outlines distinctly and clearly his technique for the treatment of pelvic malignancies. Intensity curves of radium applicators and bombs are illustrated. The technique of combined radium and roentgen therapy is outlined. The conditions specifically mentioned are carcinomata of the cervix, fundus, ovaries, rectum and bladder. For neoplasms in this location, the lethal dose for most mature growths with good results has been 4 to 5 E.D., for most immature groups about 2 to 2.5 E.D. This paper should be read to be appreciated.—*E. I. L. Cilley.*

BECK, EMIL G. Some observations on the treatment of bone sarcoma. *Radiology*, Dec., 1931, 17, 1270-1274.

The ideal treatment is a combination of surgery and irradiation. Two cases are described; one a sarcoma of the upper end of the femur subjected to conservative removal of the tumor and insertion of radium, apparently cured after seven years; the other a sarcoma of the wrist and the occurring of pulmonary metastasis seventeen years after operation.

The surgeon, radiologist and pathologist should cooperate in outlining the treatment of the lesion; a biopsy is important as the malignancy grading determines to a great extent the type of treatment; surgery should be of the open method to allow greater efficiency in post-operative irradiation. The case of sarcoma of the wrist was operated on and the arm amputated just below the elbow, because the tumor became so large and painful.—*E. I. L. Cilley.*

LACKNER, JULIUS E., and LEVENTHAL, M. L. Chorionepithelioma of the uterus; report of cure in young woman presenting extensive metastases. *J. Am. M. Ass.*, April 2, 1932, 98, 1136-1139.

Chorionepithelioma presents great variation in clinical and pathologic characteristics and the prognosis of any given case is very much in question. The authors' case was of extremely cellular type and therefore considered very malignant. The uterus was entirely infiltrated

and enlarged and extension to the vaginal wall had occurred. High voltage roentgen therapy to the pelvis was instituted and hysterectomy performed after which the patient developed a cough with blood-tinged sputum. A roentgenogram of the chest revealed extensive pulmonary metastases, and roentgen therapy was then given over this area. The metastases and local nodules in the vagina disappeared and the patient is well after five years.

The cure of the extensive disease is not easily explained. Probably the patient developed a lytic substance which destroyed the cells remaining after surgical and roentgen treatment. Radical removal and high voltage therapy are certainly the best means of combatting chorionepithelioma.—*E. W. Hall.*

MISCELLANEOUS

LAURELL, HUGO. Eine Methode beim Röntgenphotographieren den grösseren Teil der schädlichen sekundärstrahlung auszuschalten. (A method of excluding the greater part of the injurious secondary radiation in roentgenography.) *Acta radiol.*, 1931, 12, 574-579.

The author describes a method of obtaining roentgenograms that are sharp and rich in contrast with hard radiation and without a Potter-Bucky diaphragm. This is accomplished by using long distances between the tube, the object and the film. The exposure time is not particularly long. An ordinary therapy tube can be used for roentgenography also and while roentgen treatment is going on several patients can be roentgenographed at the same time with the same tube.—*Audrey G. Morgan.*

SIEVERT, ROLF, and FORSSBERG, ARNE. The time factor in the biological action of x-rays. *Acta radiol.*, 1931, 12, 535-551.

The time factor when treating with protracted fractional irradiation is very complicated. In order to obtain results that can be used in radium and roentgen treatment, a large number of investigations must be made with biological objects that differ widely in nature. The authors used *Drosophila* eggs. They are not very suitable for the experiments on account of their rapid development but they are easily obtainable in large quantities, their development is particularly constant and they are very sensitive to irradiation. They were exposed to rays of varying intensity and the re-

sultant death rate determined. They were given dosages of 83 to 220 r with exposure times varying from 2.1 to 3,600 seconds. Tables and graphs are given showing the details of the results. It was found that the death rate is the same when a dose of 165 r is given over any time varying from 2.1 to 1,800 seconds. The same results are obtained with larger and smaller dosages, at least from 83 to 220 r and with irradiation times exceeding 5 to 10 seconds. The authors found, as did Packard, that with intensities below about 5 r per minute the death rate falls very rapidly; but these low intensities, which necessitate comparatively long irradiation times, are not suitable for studies of the time factor because of the rapid development of the eggs.—*Audrey G. Morgan.*

ÅKERLUND, ÅKE. An improved model of serial frame. *Acta radiol.*, 1931, 12, 530-534.

The author describes an improved model of the duodenal serial frame that he has now been using for more than twelve years. It is entirely of metal and by its use 4 erect pictures can be taken on one 18"×24" film. It may be provided with a cylindrical or conical anterior diaphragm. The conical diaphragm is particularly adapted for use in oblique projections and because of its conical shape causes very little inconvenience even to sensitive patients. Both the cylindrical and conical diaphragms may be provided with different compression caps either in the form of aluminum cups or pneumatic rubber compressors attached to the brim of the tube facing the patient. The serial frame can be used without either the diaphragms or the compressors but the quality of roentgenograms obtained with them is much better.—*Audrey G. Morgan.*

LOVISATTI, NICOLA. L'azione dei raggi X sulle ghiandole sudoripare dell'uomo. (The action of roentgen rays on the sweat glands of man.) *Arch. di radiol.*, 1931, 7, 1107-1112.

The author irradiated a small field on the palm of the hand to determine whether roentgen irradiation causes any changes in the secretion of the sweat glands. Moderately soft rays were used up to doses of 1,500 r with a spark gap of 30 cm. and a filter of 3 mm. aluminum. With a special technique which he describes he took imprints of the mouths of the sweat glands before irradiation and up to a month afterward. There was no appreciable change in the secretion of the glands.—*Audrey G. Morgan.*

VISCHIA, QUINTINO. Alcune esperienze col focometro ad aghi di Busi e col focometro a reticella metallica. (Experiments with Busi's needle focimeter and with the metal screen focimeter.) *Arch. di radiol.*, 1931, 7, 1094-1106.

The author describes the different methods used for determining the point of emergence of roentgen rays, and after a comparative study of Busi's needle focimeter and the focimeter with a metal grating, both of which are illustrated, he concludes that the needle focimeter is superior. He finds that variations in the charge of the tube and in the exposure time and the use of a re-enforcing screen do not change the size of the focus. The greatest perfection of detail is obtained with tubes with a linear focus. The gradation in the size of the needles and the eyes in the Busi focimeter make it possible to detect the slightest defects in construction and he advises the makers of tubes to add a focimeter test to the tag which shows the value of the charge of the tube.—*Audrey G. Morgan.*

DE BRUIN, G. Le danger des films radiographiques à base de nitrocellulose. (The danger in using roentgen films with a base of nitrocellulose.) *Acta radiol.*, 1932, 13, 80-86.

From a theoretical and experimental study of the subject the author concludes that in storing films with a nitrocellulose base the storage room should be constructed in such a way that in case of fire the gas produced can expand freely so as to avoid explosion from compression. The films should be kept at as low a temperature as possible. They should be stored in such a way that the heat of decomposition cannot raise the temperature above the usual degree. The storage room must be well ventilated so that the gaseous products of decomposition will be carried away.—*Audrey G. Morgan.*

NIEMANN, C. Das direkte Messen der Röhrenspannung im Therapiebetrieb mit einem Zeigerinstrument. (The direct measurement of the tube tension in therapy with a pointer instrument.) *Strahlentherapie*, 1931, 41, 199-200.

A pointer instrument which permits one to read the high voltage on the roentgen-ray tube directly is presented. It is constructed on the potentiometer principle whereby a certain measurable voltage is taken off a series of con-

stant high ohmic resistances which connect the two lines of the high voltage side, that is, which are parallel to the roentgen tube. If the voltage ratio is known, the tube voltage can be measured. The voltage taken from the potentiometer is rectified with a small rectifier tube and smoothed out by a condenser and therefore the peak voltage can be measured by means of an electrostatic voltmeter. The resistances, the condenser, the rectifier tube and its filament transformer are enclosed in oil and form a relatively small compact unit. The instrument can be used only for continuous direct current apparatus.—*Otto Glasser.*

HEEREN, J., and HUMMEL, R. Schwankungen des Milchsäurespiegels des Blutes nach Röntgenbestrahlung von normalen und pathologischen Körpergeweben. (Variations in the lactic acid content of the blood after roentgen irradiation of normal and pathological body tissues.) *Strahlentherapie*, 1931, 42, 784-791.

The authors report experiments which confirm the findings of Joos and Heeren that immediately after irradiation of malignant tumors there is an increase of lactic acid in the blood. On irradiating normal tissue of individuals who do not have cancer there is no increase of lactic acid and in the majority of cases it is even decreased immediately after irradiation. Patients with malignant tumors who showed a rise in the lactic acid content of the blood after irradiation of the tumor were irradiated afterward on a normal part of the body (the thigh) and showed a decrease of lactic acid. Irradiation of tuberculous or other pathological tissue except tumors caused a decrease of lactic acid in the blood immediately after the irradiation. In some cases the decrease of lactic acid had been compensated in two hours and in others there was a still further fall after this time.—*Audrey G. Morgan.*

ADLER, KARL, and ADLER, MARG. Der Einfluss der Röntgenbestrahlung auf den Natriumspiegel des Blutserums. (The effect of roentgen irradiation on the sodium content of the blood serum.) *Strahlentherapie*, 1931, 42, 584-590.

The effect of roentgen irradiation on the sodium content of the blood serum was tested. In rabbits that had been given a surface dose of 1000 r the sodium content of the blood serum

was reduced by from 6.54 to 15.24 per cent of its original value. There was no lowering of the sodium content of the blood in rabbits that were given the usual therapeutic doses of roentgen or radium irradiation. This disagrees with the results of Kroetz who found an increase in the sodium content of the blood after roentgen irradiation. Kroetz used a different method of determining the sodium, the gravimetric method of Kramer and Tisdall, while the authors used the iodometric method of H. Muller, and he irradiated a smaller surface, but even taking these facts into consideration the authors are unable to account for the contradiction.—*Audrey G. Morgan.*

KADING, KURT. Die Einfluss der Röntgenbestrahlung auf die Alkalireserve des Blutes. (The effect of roentgen irradiation on the alkali reserve of the blood.) *Strahlentherapie*, 1931, 42, 571-583.

The alkali reserve of the blood is, as a rule, constant but it is affected by different factors, such as disease, anesthesia, work, extreme changes of temperature and the action of irradiation. The values may fall decidedly in the acidotic direction but they do not rise to marked alkalosis. The author found very low, that is acid, values in genital tumors. He also found that after roentgen irradiation the alkali reserve changes; in some cases it rises in the alkalotic direction and in others falls. He has not examined a large enough number of cases so that definite conclusions can be drawn from them. In one of the cases that he describes the alkali reserve was found about the same on the different examinations. This is in agreement with the results of Michalowski who found that the alkali reserve did not fall after weeks on an acid diet, showing that the organism tries to keep the alkali reserve at the same level and is generally capable of doing so. But if examinations had been made more frequently it is probable that variations would have been found. The experiments are being continued as the effect of roentgen rays on alkali reserve is important.—*Audrey G. Morgan.*

WINTZ, HERMANN. Untersuchungen über den Zeitfaktor. (Studies on the time factor.) *Strahlentherapie*, 1931, 42, 591-598.

A comparative study was made of the effect of irradiation of the ovary when the whole dose was given at once and when the fractional

method was used. It was found that the cells that were undergoing rapid division recovered very quickly from the effect of irradiation while resting cells showed a cumulative action. Applying these results to the treatment of carcinoma it would mean that the carcinoma cells would recover more quickly than the normal cells and that therefore fractional irradiation is not a good method but that the whole dose should be given at once.—*Audrey G. Morgan.*

STUHMER, A. Die Ausbildung in der Röntgenkunde auf dem Gebiet der Dermatologie. (The need of education in roentgenology for dermatologists.) *Strahlentherapie*, 1931, 42, 599-604.

Serious mistakes have been made by dermatologists in using roentgen rays for the treatment of skin diseases. Such mistakes can be prevented only by having dermatologists trained in roentgenology. Even students of general medicine should now be given instruction in roentgenology and every university should have a chair of clinical roentgenology and an institute for teaching and research in roentgenology. Instruction should be given in roentgen physics, knowledge of roentgen apparatus, roentgen biology and general clinical roentgenology, as well as light biology and light therapy. More emphasis should be placed on roentgenology in clinical instruction. But when it comes to treating skin diseases the treatment should be in the hands of a dermatologist trained in roentgenology and not in the hands of a roentgenologist. In a skin disease such as eczema for instance the treatment must be adapted constantly to the changing conditions and a thorough understanding of these conditions is necessary in order to be successful with even salve treatment and still more in judging just the right time for the use of a given amount and kind of radiation. No amount of skill in roentgenology alone can be substituted for this intimate knowledge of the course of skin diseases so that roentgen treatment in these diseases should always be under the absolute control of the dermatologist.—*Audrey G. Morgan.*

BIRCHER, E. Suit in a case of radium injury withdrawn by the plaintiff. *Schweizer med. Wchnschr.*, 1930, 60, 621.

This is an interesting detailed report of a medico-legal radium case. It does not lend it-

self to abstracting but is recommended for study in the original because of its complete analysis of the expert testimony.—*E. A. Pohle.*

GIGON, A., and NOVERRAZ, M. Organs as emitters of radiation. *Schweizer. med. Wchnschr.*, 1930, 60, 585.

The mitogenetic radiation (Gurwitsch) can only be detected by complicated methods. Stempell suggested, therefore, the use of the so-called Liesegang's rings which form on an ammonium bichromate gelatin plate if a drop of a 20 per cent silver nitrate solution is placed in its center. Positive reactions were obtained by him with onion roots. The authors repeated these experiments with a number of tissues, particularly carcinomatous tumors of the prostate, liver, colon, and ovary. They found that it was best to make up the gelatin plates in a dark room. Five minutes' exposure to daylight or ultraviolet rays produced a narrowing of the silver chromate rings. Moisture had the opposite effect. Carcinomatous tissue disturbs in some cases the ring formation very distinctly while other tissues had no effect at all.—*E. A. Pohle.*

NEEFF, TH. C. Zur Dosierung mit der Sabouraud-Noiré Tablette. (Dosage with Sabouraud-Noiré tablets.) *Strahlentherapie*, 1931, 41, 114-123.

Neeff calls attention again to the fact that the method most commonly used for measuring roentgen-ray dosage with the Sabouraud-Noiré tablet, by placing this tablet and its holder in the center of the radiation beam, may easily lead to inaccuracies, especially in regard to the homogeneity of the irradiated area on the skin. This source of error is especially great when soft rays are used. In a large series of measurements and conclusions drawn therefrom the author indicates the change in radiation quantity and quality produced by the tablet and by the holder in practical therapy and presents a method which avoids these undesirable changes. The results also explain several misconceptions which have been published recently in the literature in regard to dosage measurements with the Sabouraud-Noiré tablet.—*Otto Glasser.*

GRAF, H. Ueber einen neuen Oberflächen-therapie-apparat mit einer kombinierten Glühventil-Röntgenröhre. (On a new apparatus for superficial therapy using a com-

bined valve roentgen tube.) *Strahlentherapie*, 1931, 41, 124-131.

A compact apparatus for superficial roentgen therapy is described. It embodies several new features which permit the building of a transformer, current regulator, tube stand, valve tube and roentgen tube into one flexible and movable unit. The tube is a combined valve and roentgen tube. It is mounted together with a cylindrical shaped condenser into the flexible arm of the tube stand. The base of the tube stand contains the main transformer and the filament transformers. An efficient stabilizer built upon the principle suggested by Pugnovanoni keeps current and voltage constant. A switchboard is not necessary since the voltage is always kept at 80 peak kv. and the current at 3 ma. The tube is completely surrounded by protective metal. The apparatus, which is built by the Siemens-Reiniger-Weiss Company of Berlin, requires only about one-third of the space of the older skin therapy machines of identical efficiency.—*Otto Glasser*.

FUHS, H., and KONRAD, J. Zur Dosierungsfrage in der Roentgen-Hauttherapie. (The question of dosage in roentgen skin therapy.) *Strahlentherapie*, 1931, 41, 101-113.

In connection with a previous publication on late reactions of the skin after roentgen therapy, the authors give a detailed report on the technique and dosage for dermatological roentgen therapy as used on about 10,000 patients at the Vienna Dermatological Clinics of Arzt and Kerl. In a comprehensive table they collect about 40 types of dermatitis which react favorably to roentgen and grenz rays. Detailed dosage formulae and suggestions for a combination of radiation treatment with other dermatological therapeutic methods are given for each of the skin diseases enumerated in the table.—*Otto Glasser*.

LUNTZ, A. Ueber die Bedeutung des Zeitfaktors für die Wirkung der verzettelten Radiumbestrahlung auf *Eudorina elegans*. (The importance of the time factor on the effect of fractional doses of radium rays upon *Eudorina elegans*.) *Strahlentherapie*, 1931, 41, 132-134.

The effect of fractional doses of mesothorium (0.2 mm. silver filter) upon *Eudorina elegans* depends to a large degree upon the time interval

between the applications of the radiation. The author thinks that a first small radiation dose produces a reaction in the organisms which influences the resistance against further radium radiation and that this resistance depends upon the time interval. Further experiments are announced which may throw light upon this hypothesis.—*Otto Glasser*.

SUETSUGU, J. Experimentelle Untersuchungen zur Frage der Radiumsekundärstrahlung. (Experimental investigations on the secondary radiation of radium.) *Strahlentherapie*, 1931, 40, 401-426.

The intensity distribution of the secondary beta radiation for the radium preparations used for therapeutic purposes was examined by means of superficial cultures of *B. prodigiosus*, by *Ascaris* eggs and with the photographic method. Radium element was used in tubes of 6.6 and 13.3 mg. radium in platinum filters of 1 mm. thickness. Pertinax, aluminum, copper, silver and lead were used as secondary radiators. Control experiments were made with roentgen rays produced at 180 kv. and filtered with 0.5 mm. of copper, corresponding to a half-value layer of 0.95 mm. of copper. The distance of the secondary radiator from the cultures was 0.5 to 1 mm. and was always kept exactly the same in the experiments. It was found that the secondary radiation increases considerably with the increasing atomic weight for hard roentgen rays. For the emerging radiation of radium there is a minimum of secondary radiation for substances of medium atomic weight, while the secondary effect from lead is only slightly higher than that from pertinax. The experiments with *Ascaris* eggs did not show different effects for the emerging radiation but for incident radiation there was again an increase of the effect with increasing atomic weight of the secondary radiator. Anaerobic *Ascaris* eggs which were irradiated showed the same result whereby the effect of the secondary radiation from lead was about three times that of pertinax. In the photographic experiments a minimum effect of the secondary radiation for radiators of medium atomic weight was also observed for the emerging radiation and the continued increase with increasing atomic weight for the incidental radiation. It would seem from these experiments that in order to reduce the secondary radiation of filters employed in practice it is advisable to use second-

ary radiators of materials of an atomic weight in the neighborhood of zinc.—*Otto Glasser*.

PALMIERI, G. G. Theoretische Grundlagen eines neuen Verfahrens der Homogenbestrahlung mit Gammastrahlen. (Theoretical foundations of a new method of homogeneous radiation treatment with gamma rays.) *Strahlentherapie*, 1931, 40, 470-492.

Using his compensation and superfilters which are designed to make the radiation intensities falling upon the skin from an extracorporeal radiation source homogeneous, the author calculates the radiation intensity on the surface and in the depth of various combinations of radiation sources. The theoretical results obtained by calculation were checked by ionization measurements with a Mallet-Danne ionomicrometer. It was found that an arrangement of the gamma-ray sources is possible which produces (1) a homogeneous distribution of the gamma-ray energy on the surface of an area of any desired size, (2) a homogeneous distribution of the gamma-ray energy throughout a considerable volume and to a considerable depth using any one single surface area and a battery of four radiation sources, (3) the same distribution as in (2) but using two diametrically opposed radiation sources. A series of diagrams illustrates the author's method of producing space homogeneity of gamma rays in air and in water and presents a conception of a standard technique for simplification and standardization of curie therapy.—*Otto Glasser*.

BODE, H. G. Ein weiterer Beitrag zur Histologie sensibilisierter roentgenbestrahlter Haut. (An additional contribution to the histology of sensitized skin radiation with roentgen rays.) *Strahlentherapie*, 1931, 40, 515-545.

The skin of guinea pigs was sensitized during three days with tincture of iodine, croton oil and chrysarobin vaseline. Two weeks later the sensitized spots were completely normal macroscopically and only a very small change could be detected by histological examination. On the 5th, 7th, 9th, 11th and 15th days the sensitized spots were treated with a dose of

950 r of unfiltered roentgen rays. Two weeks after the irradiation, distinct changes in structure of the sensitized and irradiated skin areas were observed as compared with the skin which was only irradiated. The maximum of the degenerative changes for the skin treated with tincture of iodine and croton oil was found on the 9th and 7th day respectively after sensitization. For the skin sensitized with chrysarobin vaseline there was a decrease in the effect observed after the 5th day.—*Otto Glasser*.

EPSTEIN, S. Der Einfluss des Tubus auf die Dosis. (The influence of the treatment cone upon dosage.) *Strahlentherapie*, 1931, 40, 493-507.

Various arrangements of treatment cones in deep therapy tube stands can cause variations in the radiation dose up to 20 per cent. Dosage measurements made with the Küstner "Eichstandgerät" show that these variations are caused by three factors: (1) secondary radiation of the filter, (2) stem radiation, (3) absorption in the wooden bottom of the cone. These factors have to be observed in the calculation and measurement of treatment dosages.—*Otto Glasser*.

FISCHER, A., and HORWITZ, M. Multiplikation der Wirkung kleinster Radiumdosen auf Gewebezellen in Vitro. (Multiplication of the effect of small radium doses upon tissue cultures in vitro.) *Strahlentherapie*, 1931, 40, 465-469.

The authors irradiated cultures of osteoblasts with small doses of mesothorium with radium equivalent of about 0.25 mg. per hour and observed the inhibitory effect upon the growth of the fibroblasts. The experiments were made with the tissues at various temperatures (from 0° up to 50° C.) before and after the irradiation. The results show that the effect of small doses upon these tissue cultures can remain latent but by adding further small doses under various conditions it still can be shown to exist. The authors draw the conclusion that the absolute radiation effect does not depend upon the rate of proliferation of the tissue cells.—*Otto Glasser*.



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SIGNIFICANCE OF ROENTGENOLOGIC CHANGES IN DIFFERENTIAL DIAGNOSIS OF ATELECTASIS*

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ATELECTASIS, or the absence of air in the alveoli, may be local, limited to a few of the alveoli, or general, involving a whole lobe or an entire lung. It is of two general varieties, congenital and acquired, and is associated with a number of conditions (Tables I, II, III and IV).

Bowen² in 1928 reviewed the literature of the condition up to that date, and while he was particularly interested in the post-operative form of atelectasis, his splendid paper contains an exhaustive bibliography of the whole subject.

Congenital atelectasis is commonly looked upon as a failure of the lung to expand because of maldevelopment of a bronchus, or of some fault of the respiratory mechanism. The acquired form is always due to bronchial occlusion.

In both congenital and acquired atelectasis, the roentgenographic findings fall into two classes: (1) increase in the density of the shadow of the collapsed lung or part of the lung due to the absence of air, and according to Sante¹³ to vascular engorgement; (2) displacement of the mediastinal structures toward the side of the collapse with elevation of the diaphragm on the affected side (Table IV).

Congenital atelectasis is not a common occurrence, one of us⁵ having failed to find

an instance in a consecutive series of 150 infants examined roentgenographically within twenty-four hours of birth. Failure of the respiratory mechanism is generally considered the cause; but bronchial occlusion due to foreign material inhaled immediately after birth may be responsible, and cases looked upon as congenital may be acquired.

Congenital atelectasis is usually lobar and has the roentgenologic density of consolidation (Fig. 1); or it may be widely disseminated and made up of smaller patches. It is differentiated from enlarged thymus by the absence of thymic outline. Lobar pneumonia in the new-born is difficult to differentiate from congenital atelectasis; indeed, many cases diagnosed as pneumonia in new-born infants are probably atelectasis due to bronchial occlusion by aspirated foreign material.

Acquired atelectasis is always due to complete occlusion of a bronchus with absorption of the air distal to the occlusion. It is an accompaniment of several intrabronchial and a few extrabronchial conditions. Completely occluding foreign body, postoperative collapse of the lung, bronchial new growth, pneumonia, tuberculosis, and asthma, are conditions in which lesions within the bronchus are responsible for atelectasis. Enlarged tracheobronchial lymph

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

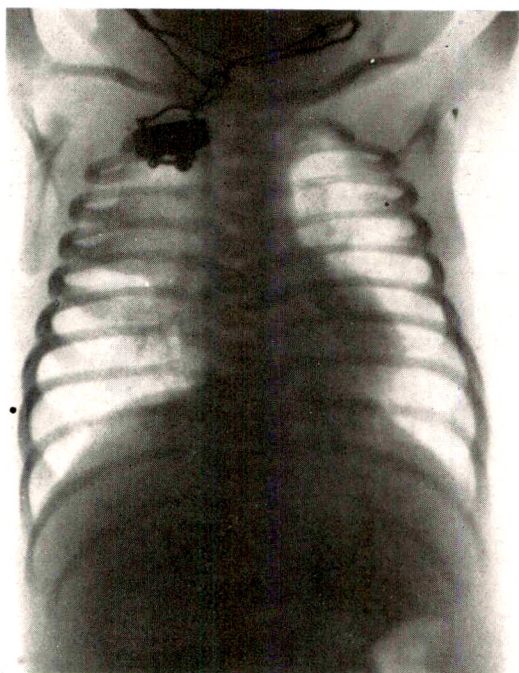


FIG. 1. Congenital atelectasis. Baby S., one day old; patient of Drs. Thaddeus L. Montgomery and Edward F. Burt; cyanosis, wheeze; upper portion of right chest evenly dense due to failure of upper lobe to expand. Ribs unelevated over this portion of chest. Roentgenograms made ten days later showed a normal chest.

nodes, mediastinal new growth and aneurysm are extrabronchial lesions, which by pressing on a bronchus, occlude it and lead to pulmonary collapse.

The roentgenologic changes of increased shadow density and displacement of the mediastinal structures and diaphragm are the same, regardless of the condition with which the atelectasis is associated. The findings vary, however, with the size of the bronchus occluded, the side involved, the duration of the collapse and the character of the changes in the bronchus and pulmonary parenchyma secondary to the bronchial lesion.

Alterations in the roentgenologic appearance of the chest secondary to totally occluding bronchial foreign body based on clinical observations have been described by one of us (Manges).^{10,11,12} Heller,⁸ among others, has described the changes observed clinically and experimentally. The atelectatic changes in foreign body demonstrate well the effect of total bronchial occlusion and will be presented in detail.

Totally occluding bronchial foreign bodies occur more frequently in children than

TABLE I
MECHANICS AND INCIDENCE

	Type	Occluding Factor	Incidence of Atelectasis in Primary Condition
	Congenital	1. Respiratory dysfunction 2. Inhalation of foreign material	Rare
Due to occlusion by intrabronchial plugging	Foreign body Bronchial neoplasm Postoperative Pneumonia	Foreign body Neoplasm Tenacious secretion Pneumococcic exudate	Occasional Usual Always Always (Coryllos and Birnbaum)
	Tuberculosis Asthma	Granulations Tenacious secretion	Uncommon Rare
Due to occlusion by extrabronchial pressure	Tracheobronchial nodes Mediastinal neoplasm Aneurysm Extrabronchial pulmonary neoplasm	Pressure by nodes Pressure by growth Pressure by aneurysm Pressure by neoplasm	Rare Rare Rare Common

in adults and are usually organic in origin, the dried navy bean being the most frequently encountered. However, inorganic foreign bodies may produce atelectasis; in one instance the inhalation of a steel bullet was responsible for the condition.

With total occlusion of a bronchus by a foreign body it is impossible for air to enter or leave the lung distal to the point of lodgment. Jackson calls this type of foreign body the stop-valve. Absorption of the air trapped in the lung by the foreign body follows and the alveoli collapse. Collapse is due to the fact that, after the intrapulmonary pressure has been reduced to less than atmospheric by the cutting off of the alveoli from the outside air, the negative pressure in the pleural cavity is not sufficient to counteract the contracting force of the pulmonary elastic tissue. Decrease in air content leads to diminution in the size of the lung.

Alteration in the roentgen appearance due to collapse becomes evident as a loss of illumination on the side involved (Fig. 2). This is so marked that the collapsed lung cannot be differentiated from the shadow of the heart and other mediastinal structures and the diaphragm.

The extent of the area of increased density is determined by the amount of lung tissue normally supplied by the occluded

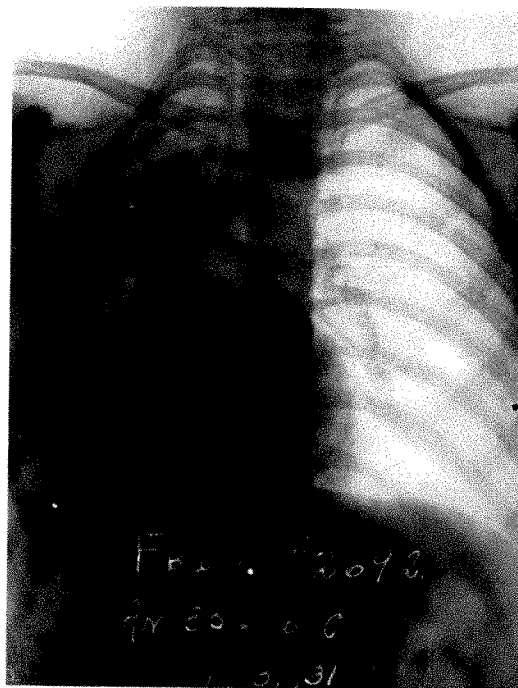


FIG. 2. Total collapse of right lung following aspiration of bean. M.C., aged five; patient of Dr. Louis H. Clerf; bean aspirated twenty-four hours earlier; right half of the chest evenly dense due to collapse, heart and mediastinal structures displaced far to the right.

bronchus. Closure of a main bronchus leads to collapse of the whole lung; of a branch bronchus, to collapse of a smaller area; in the case of a lobar branch, of a lobe; in the

TABLE II
CLINICAL SIGNIFICANCE

	Age Incidence	Prognostic Significance
Congenital	New-born	
Foreign body	Childhood	
Bronchial neoplasm	Middle age	
Postoperative (massive atelectasis)	Any age, usually adult	
Pneumonia	Any age	
Tuberculosis	Early adult, middle age	
Asthma	Adult	
Enlarged tracheobronchial nodes	Infancy and childhood	Grave
Mediastinal neoplasm	Middle and late adult	Grave
Aneurysm	Late adult	Grave
Extrabronchial pulmonary neoplasm	Middle age	

case of a small branch, of only part of a lobe.

Changes in the position of the thoracic viscera accompany atelectasis. Diminution in the size of the collapsed lung leads to compensatory emphysema of normal pulmonary tissue. This overdistention of the normal lung forces the movable mediastinal

sis experimentally in two hours in

In foreign body atelectasis the of the roentgenographic signs removal of the foreign body depends directly upon the length of sojourn of foreign body. If the foreign body is moved promptly, expansion of the lung takes place quickly, the displaced

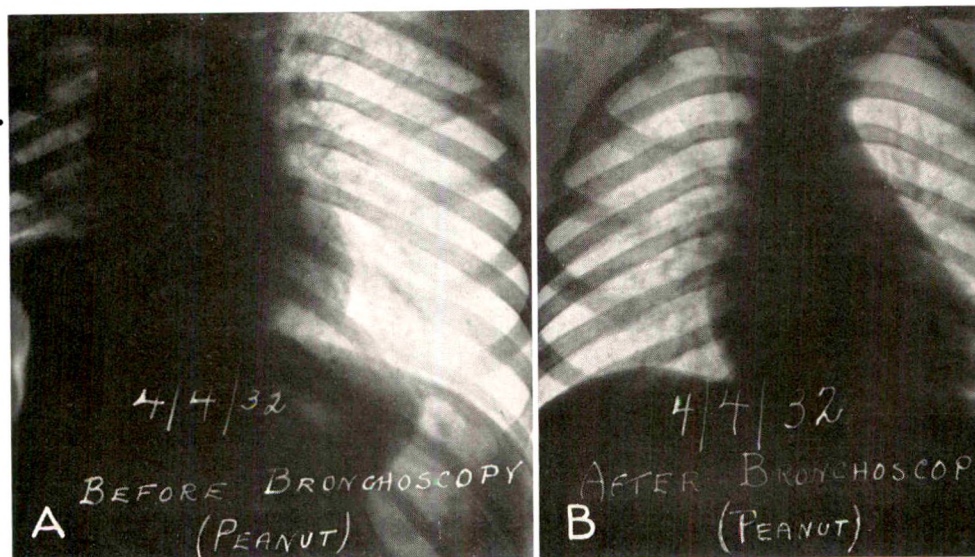


FIG. 3. Rapid re-expansion of atelectatic lung after early removal of occluding foreign body. B.T. patient of Dr. Louis H. Clerf; peanut aspirated April 3, 1932; dyspnea, cyanosis, loss of consciousness a few minutes. A. April 4, 1932, seventeen hours after onset; right lung increased in density, placed to right, right half of diaphragm elevated. B. April 4, 1932, one hour after Dr. Clerf had a peanut from the right main bronchus. Lung re-expanded, markings practically normal.

structures away from the uninvolved side toward the side of the atelectasis.

The degree of displacement is determined by the side involved as well as the site of the occlusion, and by the feasibility of the mediastinal structures. Closure of the bronchi supplying the left lung is accompanied by less marked displacement than when the right lung is involved. When but a single lobe is collapsed displacement is not so great as when all the lobes of a lung are involved.

Atelectasis secondary to foreign body occlusion takes place rapidly. We have seen complete collapse of the lung develop in a child six hours after the inhalation of the foreign body. Lee, Ravdin, Tucker and Pendergrass⁹ were able to produce atelecta-

return to their normal positions chest resumes a wholly normal roentgenologic appearance in a brief time. The entire process of occlusion, at evacuation and re-expansion may take place in a few hours.

Two varieties of intrabronchial changes follow longer sojourn of foreign body in the bronchus: (1) reaction in the bronchial mucosa at the site of lodgment; (2) changes in the pulmonary tissues distal to the site of occlusion. The latter are due to chronic atelectasis, fibrosis and emphysema.

Vegetal foreign bodies, such as navy bean, swell when held in the mouth for any length of time. This swell

accompanied by traumatization of the mucous membrane. In some instances pressure on the swollen foreign body by the walls of the bronchus forces the object upward, an action similar to that following the squeezing of a moistened hard object between the thumb and finger. Shifting by this action of a foreign body from one main bronchus to the other may lead to sudden death, be-

occurs in foreign body atelectasis because the rapidity of onset prevents adjustment of the secretory function and mechanism, while in postoperative collapse the etiologic factor, a conversion of the normal thin bronchial secretion into a thick ropy substance, permits of adjustment.

The influence of drowned lung on the roentgenographic appearance of the atel-

TABLE III
CLINICAL CHARACTERISTICS

Type	Onset	Symptoms	Constitutional Reaction	Commonest Sequelae
Congenital	Immediate	Dyspnea, cyanosis, wheeze	Mild	None
Foreign body	Sudden	Cough, dyspnea, wheeze	Moderate to severe	Pneumonitis, bronchiectasis
Bronchial neoplasm	Gradual	Cough, expectoration, hemoptysis, pain	Mild	Pneumonitis, abscess
Postoperative	Sudden	Dyspnea, cough, pain, cyanosis	Severe ("Catastrophe" Lee)	Usually none
Pneumonia	Sudden	Cough, dyspnea, cyanosis, pain	Severe	Empyema, abscess
Tuberculosis	Gradual	Cough, expectoration, dyspnea	Mild	Bronchiectasis
Asthma	Sudden	Dyspnea, wheeze	Severe	None
Tracheobronchial nodes	Gradual	Cough, dyspnea	Severe	Empyema
Mediastinal neoplasm	Gradual	Cough, dyspnea	Severe	Pneumonitis, abscess
Aneurysm	Gradual	Cough, dyspnea	Mild	Pneumonitis, abscess
Extrabronchial pulmonary neoplasm	Gradual	Cough, pain	Mild	Abscess

cause collapse of the formerly sound lung may take place before the lung which first became atelectatic has become sufficiently aerated. With conversion of a bronchial into a tracheal foreign body re-expansion of the atelectatic lung takes place, and the roentgenographic signs become those of tracheal foreign body.

Rapidly developing foreign body atelectasis is accompanied by retention of bronchial secretions in the lung distal to the occlusion, a condition known as drowned lung. This does not occur in postoperative collapse. Bowen² says that drowned lung

ectatic lung is determined by the duration of the collapse and the local pathological changes at the site of occlusion. With prompt removal of the foreign body and re-expansion of the lung the retained secretions are rapidly expelled from the collapsed area and no appreciable roentgenologic alteration remains.

Prolongation of collapse is followed by infection of the retained secretions, and even after the occluding object has been removed from the bronchus and the atelectasis relieved there is a residual increase in the density of the shadows of the in-

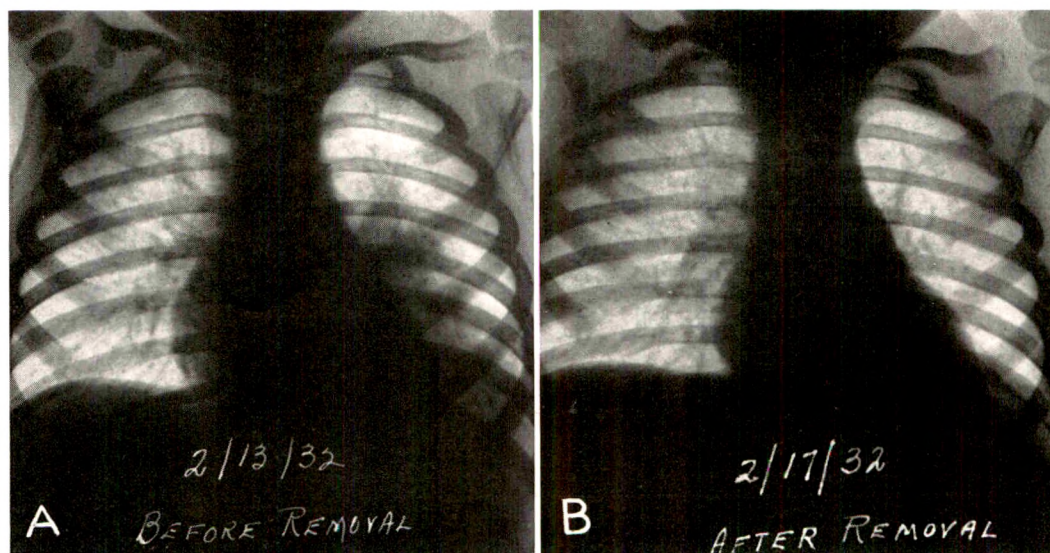


FIG. 4. Residual increased density due to prolonged bronchial occlusion and atelectasis. C.A., aged two; patient of Dr. Louis H. Clerf; peanut aspirated January 31, 1932; cough, wheeze, expectoration and fever. A. February 13, 1932, two weeks after onset; lower half of left lung increased in density. B. February 17, 1932, four days after bronchoscopic removal of peanut from left lower lobe bronchus by Dr. Clerf. Markings still increased over lower lobe, left half of diaphragm elevated.

involved lung (Fig. 4). This residual increase may be marked and approach that of atelectasis, or it may be made up of a varying number of independent dense areas due to suppurative foci.

When collapse has not been prolonged

and no local bronchial lesion interferes with drainage, the roentgenologic changes due to infection of the drowned lung gradually disappear. The length of time required for complete disappearance varies from a few days to several weeks.

TABLE IV
ROENTGENOLOGIC CHARACTERISTICS

Type	Roentgenologic Density	Distribution	Displacement
Congenital	Varies with involvement	Lobar, lobular, entire lung	Not marked
Foreign body	Varies with involvement	Lobar, entire lung	Varies with involvement
Bronchial neoplasm	Varies with involvement	Lobar, lobular, entire lung	Varies with involvement
Postoperative	Usually marked	Entire lung, lobar, broncho-pneumonic	Marked
Pneumonia	Marked	Lobar	Moderate, not as marked as postoperative
Tuberculosis	Varies with involvement	Lobular, lobar	Varies with involvement
Asthma	Marked	Lobar	Marked
Tracheobronchial nodes	Marked	Lower lobes	Marked
Mediastinal neoplasm	Marked	Lower lobes	Varies
Aneurysm	Marked	Lobar	Varies
Extrabronchial pulmonary neoplasm	Varies with involvement	Lobar	Not marked

Sometimes, inflammatory changes in the retained secretions increase so rapidly in amount that they exert pressure on the occluding foreign body and dislodge it. This uncorking of the bronchus is followed by re-expansion of the atelectatic lung; the effect on the roentgenographic appearance of the chest being again determined by the duration of the collapse, and the extent of the inflammatory changes in the occluded bronchus and atelectatic lung.

occlusion is characterized by the development of bronchiectasis with cavities and extensive fibrous tissue changes throughout the collapsed lung (Figs. 5 and 6). Bronchiectasis secondary to atelectasis is usually unilateral and shows the characteristic displacement of the mediastinal structures toward the side of involvement, together with elevation of the diaphragm. It is accompanied by expectoration of purulent exudate and other evidences of infection.

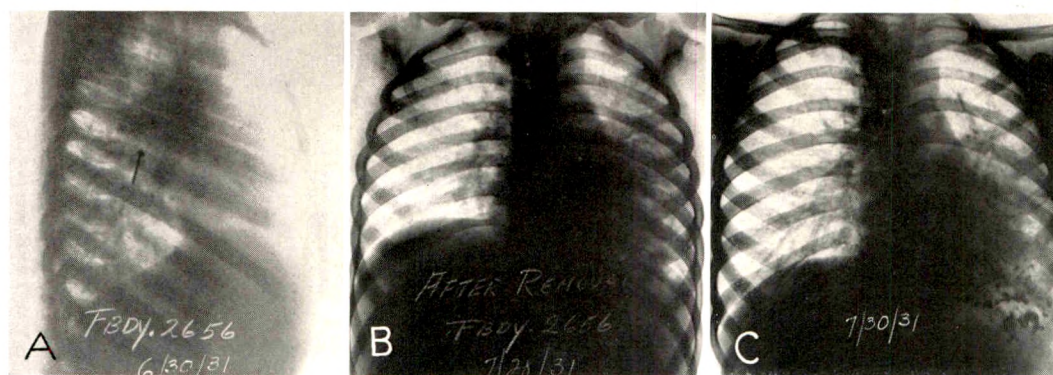


FIG. 5. Bronchiectasis secondary to foreign body atelectasis. W.F., aged seven and a half; patient of Dr. Louis H. Clerf; no history of foreign body aspiration; onset four to six months before admission with cough, expectoration of fetid pus and fever. A. Lateral view of the chest showing nail in bronchus; even in this view increased markings of lower portion of lung are apparent. B. Marked residual density still present one month after bronchoscopic removal of nail by Dr. Clerf. C. Bronchiectatic cavities outlined by iodized oil. These changes are permanent and the direct result of inflammatory processes in the atelectatic lung.

Localized trauma at the site of foreign body lodgment influences greatly the roentgenographic appearance of the atelectatic lung, even after the foreign body has been removed. Injury to the mucous membrane produces granulation tissue which, acting as a foreign body, interferes with aeration of the lung and prevents drainage. The collapsed lung, therefore, cannot expand readily, and this, together with the retained secretions, leads to continued density of the involved lung and to displacement of the viscera. The amount of increased density and the degree of displacement depend upon the degree of stenosis produced by the granulation tissue, the duration of the atelectasis and the size of the area involved.

Chronic atelectasis from foreign body

It may be mistaken for congenital cystic disease of the lung. Careful questioning will sometimes unearth a history of foreign body aspiration as the etiologic factor.

Scar formation with residual stenosis of the bronchus produced by a foreign body may also terminate in bronchiectasis even after the atelectasis has been relieved by the removal of the foreign body.

Bronchial neoplasm is essentially a foreign body of intrabronchial origin which, by occluding the bronchus at one point, produces atelectasis in much the same way as the inhaled foreign body. Atelectasis accompanying bronchial new growth produces clinical and roentgenologic characteristics important in differentiating it from other pulmonary diseases.

New growth of the bronchus is frequently so insidious in onset that atelectasis of an entire lung has taken place when the patient first comes under observation. There is a stage in its development when, acting as a check valve permitting air to enter but preventing its exit, the new growth produces obstructive emphysema.

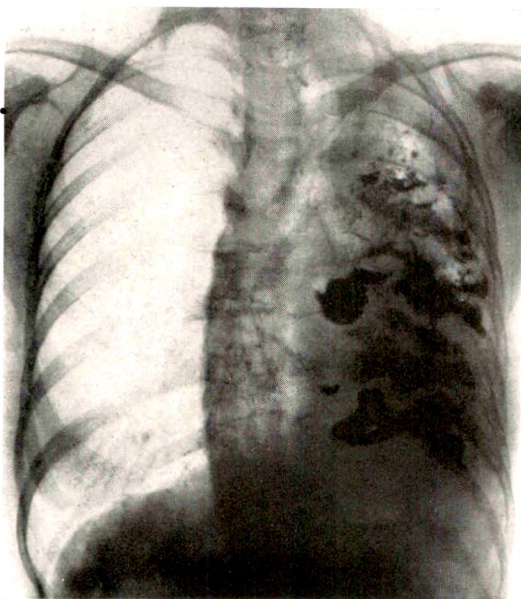


FIG. 6. Extensive bronchiectasis secondary to foreign body atelectasis. B.C., aged thirty-seven; patient of Dr. Chevalier Jackson. As child of five aspirated a coffee bean, severely ill with attack similar to pneumonia for two months. After one month coughed up bean, and was never afterwards free of cough and expectoration. At twelve years, and again at eighteen, had prostrating attacks of illness with cough, expectoration of fetid pus and fever. For fourteen months prior to admission was in a tuberculosis sanatorium, sputum always negative for tubercle bacilli. Iodized oil outlines numerous large cavities in the left lung; heart and trachea displaced to the left; left hemithorax atrophied.

Respiratory dysfunction at this time is apparently not great, and patients do not usually seek medical advice during this stage. It is possible that the condition is sometimes overlooked because its symptoms are protean and its signs vague.

Continued growth of the tumor leads to total occlusion of the bronchus with subsequent atelectasis (Fig. 7A). The extent

of the atelectasis depends upon the site in the bronchus at which the tumor arises, and this, with the duration of the atelectasis and the type of secondary change, determines the roentgenologic characteristics of the collapsed area.

Tumors arising in a main bronchus produce complete collapse of the lung on the side of the tumor with even opacity of the shadow, and displacement of the thoracic viscera toward it. When the tumor arises from a branch bronchus collapse is confined to a lobe with increase in the density of the shadow limited to the projection of the lobe and with less visceral displacement than when the entire lung is collapsed.

Removal of the obstruction by bronchoscopic removal of the tumor allows air to enter and re-expand the lung, restoring the viscera to their normal positions (Fig. 7B). The time required for this varies with the duration of the collapse and the extent of the secondary changes. Ashbury¹ reported a case in which the lung collapsed and re-expanded three times in sixteen months; in one interval expansion followed bronchoscopic removal of the tumor by Clerf. Figure 7B is of a patient whose lung had been atelectatic for seven months. Eleven weeks were required for partial re-expansion; roentgenograms made immediately after bronchoscopic removal of the tumor and for several weeks thereafter showed no appreciable difference from those made before bronchoscopy.

Roentgenographic signs of atelectasis are important in the differentiation of pulmonary abscess secondary to neoplasm from abscess unassociated with neoplasm. In pulmonary abscess uncomplicated by new growth, displacement phenomena are absent unless there is pleural involvement; then the diaphragm alone is affected, the mediastinal structures remaining in their normal position. In abscess following bronchial new growth there is practically always displacement of the thoracic organs toward the side of involvement (Fig. 8). The difference in displacement is probably accounted for by the difference in the mode

of development of the two varieties of abscess.

Acute non-neoplastic abscess follows entrance of infected material into the alveoli in an amount great enough to set up a suppurative focus, but not large enough to produce bronchial obstruction and subsequent atelectasis. Destruction extends

Postoperative atelectasis is due to occlusion of a bronchus by the accumulation of tenacious secretions too thick for the patient to expectorate. Its clinical and roentgenologic characteristics help to differentiate it from other conditions and from atelectasis of other origin. Because of increasing interest and wider recognition

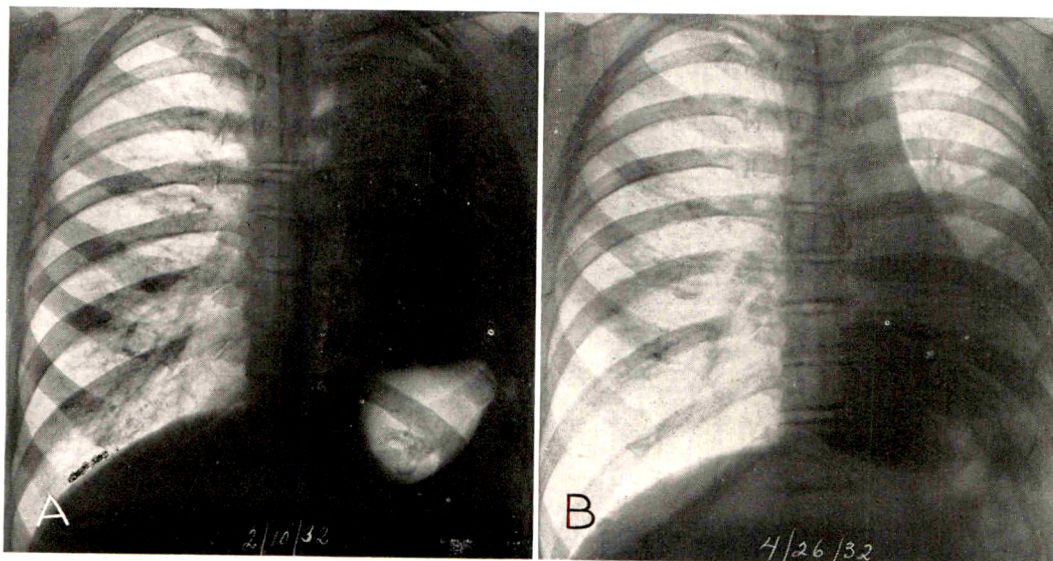


FIG. 7. Atelectasis due to bronchial carcinoma. E.P., aged forty-one; patient of Dr. Louis H. Clerf. A. February 10, 1932, sixteen months after onset with cough, fever and night sweats. Left lung evenly dense, with displacement of mediastinal structures and elevation of the diaphragm. B. April 26, 1932, partial re-expansion of the left lung after bronchoscopic removal of the tumor by Dr. Clerf.

entrifugally from a central point of origin.

Extension of the tumor from its primary site in the bronchus into the atelectatic pulmonary tissue converts the pulmonary tissue into a neoplastic mass. Necrosis of the center of the tumor and bacterial invasion bring about abscess and cavity formation. The collapsed lung remains diminished in size because the neoplastic tissue cannot expand, and, as a consequence, the thoracic viscera are held in their position of displacement.

Atelectasis as a complication of surgical operation is also known as postoperative passive pulmonary collapse. Bowen treats it exhaustively from the historical, clinical, experimental and roentgenologic aspects.

by those who have the postoperative care of the patient it is more frequently recognized now than formerly. This type may occur at any age; but it is seen in adults more often than in the young. Hearn and Clerf⁷ reported a case in a child of seven years.

Clinically, sudden onset shortly after operation and marked respiratory embarrassment out of proportion to the temperature and pulse elevation characterize it. It usually comes on within thirty-six hours of operation and may develop fully in that time; or it may begin with the first day but not reach its height for six or seven days.

Roentgenologically postoperative collapse varies with the extent of the collapse.

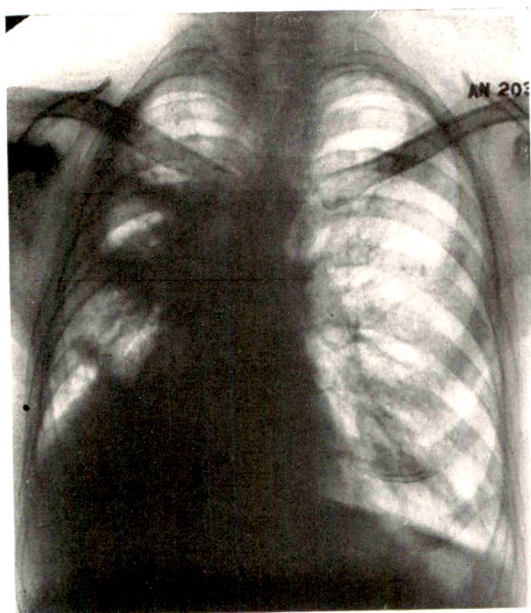


FIG. 8. Abscess in neoplastic atelectasis secondary to bronchial carcinoma. W.B., aged fifty-nine; patient of Dr. Chevalier Jackson. Cough, hemoptysis, expectoration of pus, pain. At bronchoscopy Dr. Clerf found neoplastic tissue diagnosed histologically carcinoma by Dr. Baxter L. Crawford. Cavity formation and inflammatory changes throughout the right lung. Note the marked displacement of the heart and diaphragm which are not usually present in non-neoplastic pulmonary abscess.

Early in its course in some cases there is an increase in the shadows of the involved lung with elevation of the diaphragm on the affected side (Fig. 9). The increased density of the lung is not so great that the pulmonary shadows cannot be differentiated from the heart and diaphragm. This stage is not often seen in foreign body occlusion or in occlusion due to bronchial new growth. Progression of the process ends in the development of a shadow as dense as that of the heart and diaphragm from which the lung cannot be differentiated (Fig. 10).

Fixation as well as elevation of the diaphragm on the involved side can be recognized on roentgenoscopic examination early in the course of the disease.

When the bronchi of one lobe only are occluded increase in the density of the shadow is limited to the projection of that lobe, and the mediastinal viscera are not displaced as much as they are when an entire lung is involved.

Postoperative atelectasis is sometimes patchy in distribution. In a patient whose case was reported by Scheffey, Jones and Clerf¹⁴ we found areas of increased density

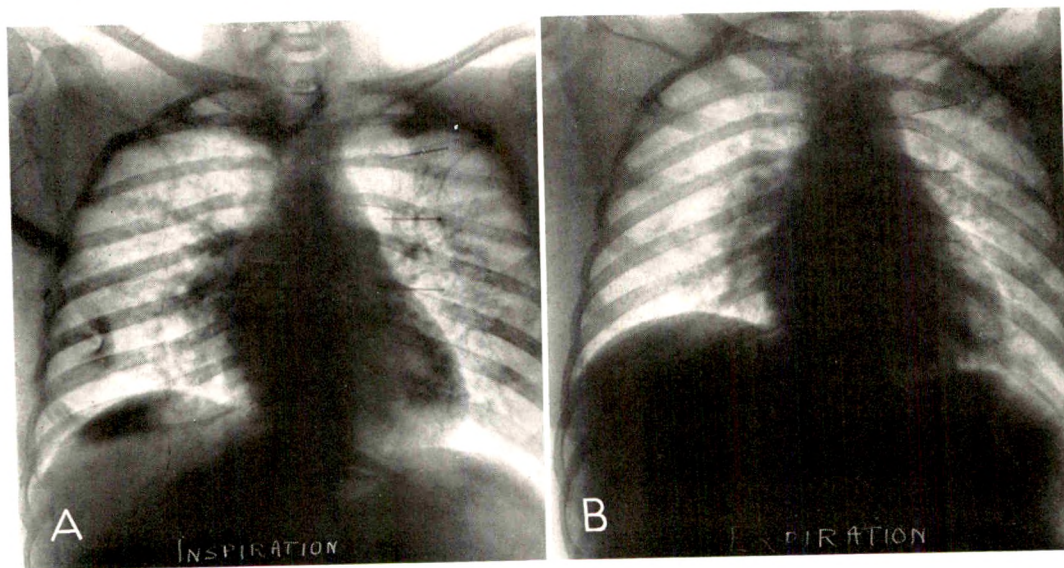


FIG. 9, A and B. Elevation and fixation of the diaphragm in early postoperative atelectasis. R.S., aged twenty-eight; patient of Dr. P. Brooke Bland. Onset two days after forceps delivery, with dyspnea and fever; marked increase in shadows at right root area.

apsed lobes and displacement of the heart and mediastinal structures toward this side of the chest. With re-expansion dyspnea lessened, the lungs assumed their usual emphysematous appearance, and the mediastinal structures returned to their normal positions.

Extrabronchial pressure leading to occlusion of the bronchus is not so common a cause of atelectasis as is closure of the bronchus due to plugging from within. The atelectasis is, however, of graver clinical significance. In most of these patients the prognosis is less favorable than in those in whom the occlusion is intrinsic in origin. The gravity is due in most part to the seriousness of the conditions with which the atelectasis is associated; but in part, also, to the atelectasis itself which may even become bilateral.

Massive collapse due to extrabronchial pressure may occur at any age, though particular causes are operative in particular age groups. In infants and children enlarged tracheobronchial lymph nodes may be responsible for the occlusion; in adults, mediastinal new growth, aneurysm and extrabronchial pulmonary neoplasm are the most frequently encountered causes.

Enlargement of the mediastinal nodes in children to a size sufficient to produce occluding bronchial pressure is always tuberculous in origin.

It is probably seen only when the nodes are fixed to the bronchi by fibrous tissue formation. As the nodes increase in size they occlude the bronchus by pressing on it from without. When not adherent enlarged nodes merely displace the bronchi and do not occlude them.

The lower lobes are more frequently involved than the upper, and the shadow of the lesion is often of an irregular pattern though the collapse extended beyond the limits of the lobe.

Marked displacement of the mediastinal structures is often associated with the occlusion. At other times, because the lesion is bilateral and involves both lower lobes, displacement is less pronounced.

Occasionally, the etiologic factor responsible for the enlargement is made evident by the presence of tuberculous deposits in the parenchyma at such a distance from the collapsed portions that they can be recognized (Fig. 12).

Gradual increase in the size of the nodes may trap secretions beyond the point of narrowing and drowned lung and infective changes may develop before the occlusion becomes complete and ends in atelectasis.

Aneurysm and mediastinal new growth may lead to atelectasis when they prevent the entrance of air into a portion of the lung by occluding the bronchus by pressure. It is not a common occurrence. We have seen one case at post mortem in which three lobes, the two lower and the right middle, were collapsed because of pressure made on the bronchi close to the bifurcation by an aneurysm. The ante-mortem roentgenogram showed bilateral increased density of the lower portions of the chest without displacement of the thoracic viscera. Figure 13 is of a patient in whom pressure from a sarcoma of the mediastinum was found at post mortem to be responsible for atelectasis as well as for atresia of the esophagus.

Extrabronchial pulmonary neoplasm sometimes produces atelectasis by pressing on bronchi. There is nothing characteristic in the changes they produce. Necrosis of the center of the neoplastic mass and evacuation of the contents leads to the formation of a cavity. As in the case of abscess secondary to intrabronchial neoplasm there is marked displacement of the thoracic viscera toward the side of involvement, a condition not ordinarily found in non-neoplastic pulmonary abscess.

SUMMARY

1. Atelectasis has certain roentgen characteristics serving to differentiate it from other conditions.

2. Congenital atelectasis is uncommon, and though usually considered due to respiratory dysfunction, it may follow occlusion of a bronchus by material aspirated with the first few inspirations after birth.

3. Acquired atelectasis in bronchial foreign body, bronchial neoplasm, postoperative massive collapse, pneumonia, tuberculosis, and asthma, is due to intrabronchial plugging; and in enlarged tracheobronchial lymph nodes, aneurysm, mediastinal new growth and extrabronchial pulmonary neoplasm it follows occlusion of the bronchus from extrabronchial pressure.

4. Roentgen phenomena of atelectasis fall into two classes: (1) increase in the density of the shadows of the involved portion of the lung, (2) displacement of the heart and other mediastinal structures toward the side of involvement, with elevation of the diaphragm on the affected side.

5. The characteristics and significance of these roentgen signs vary with the cause, the bronchus involved, the duration of the collapse and its sequelae.

6. Atelectasis due to aspirated foreign body and bronchial neoplasm is frequently followed by inflammatory changes, abscess and bronchiectasis.

7. The close association of atelectasis and bronchiectasis is not generally recognized.

8. The acute postoperative form of atelectasis, pneumococcal atelectasis, and atelectasis in asthma usually resolve without serious sequelae and no roentgenologically recognizable residues.

9. In tuberculosis atelectasis may disappear spontaneously leaving no sign or it may become chronic and end in bronchiectasis.

10. Displacement phenomena accompanying abscess suggest strongly a neoplastic origin for the abscess, because they indicate that atelectasis preceded it, a rare condition in non-neoplastic abscess.

11. Atelectasis, while rare in the extrabronchial lesions, enlarged tracheobronchial nodes, mediastinal new growth, and aneurysm, is a grave prognostic sign. When due to pressure from an extrabronchial pulmonary new growth it is of less serious import.

REFERENCES

1. ASHBURY, H. E. Recurrent massive collapse of the lung due to a benign intrabronchial tumor. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1929, 27, 452-459.
2. BOWEN, D. R. Acute massive collapse (atelectasis) of the lung. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1929, 27, 101-141.
3. CLARKE, J. A., Jr. Pulmonary atelectasis as a complication of bronchial asthma. *Arch. Int. Med.*, 1930, 45, 624-630.
4. CORYLLOS, P. N., and BIRNBAUM, G. L. Lobar pneumonia considered as a pneumococcal lobar atelectasis of the lung; bronchoscopic investigation. *Arch. Surg.*, 1929, 18, 190-241.
5. FARRELL, J. T., Jr. The roentgen appearance of the chest of the new-born infant. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1930, 24, 140-146.
6. FARRELL, J. T., Jr. The roentgen diagnosis of intrathoracic neoplasms. *Radiology*, 1929, 13, 1-16.
7. HEARN, W. P., and CLERF, L. H. Post-operative massive collapse of the lung. *Ann. Surg.*, 1927, 85, 54-60.
8. HELLER. Klinische und experimentelle Beiträge zur Kenntnis der akuten Lungenatektase durch obturierenden Fremdkörperverschluss der Bronchien. *Ztschr. f. d. ges. exper. Med.*, 1913-1914, 2, 453-484.
9. LEE, W. E., RAVDIN, I. S., TUCKER, G., and PENDERGRASS, E. P. Studies on experimental pulmonary atelectasis. *Ann. Surg.*, 1928, 88, 15-20.
10. MANGES, W. F. Atelectasis as a roentgen-ray sign of foreign body in the air passages. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1924, 11, 517-523.
11. MANGES, W. F. Non-opaque foreign bodies in the air passages. *Brit. J. Radiol.*, 1926, 31, 119-149.
12. MANGES, W. F. Bronchial obstruction, partial or complete, as shown by the roentgen-ray examination. *Proc. Inter-State Postgraduate Medical Assembly of North America*. 1931, 367-372.
13. SANTE, L. R. Quoted by Bowen, Ref. 2.
14. SCHEFFEY, L. C., JONES, H. W., and CLERF, L. H. Postoperative collapse of the lung (atelectasis) in gynecologic cases. *Am. J. Obst. & Gynec.*, 1930, 19, 795-806.
15. SPROULL, J. Collapse of the lung occurring in pulmonary tuberculosis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1928, 20, 419-423.

MULTIPLE ANEURYSMS OF THE SMALLER BRANCHES OF THE PULMONARY ARTERY*

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THE rarity of pulmonary aneurysms is attested by the infrequency of their discovery in large autopsy series. Their importance lies almost entirely in the field of differential diagnosis and prognosis.

When the rather common, small, vascular dilatations occurring in connection with pulmonary cavitation are excluded, the total number of aneurysms reported falls well below one hundred. Moench⁹ and Costa,⁴ in autopsy series of 10,000 and 20,000 cases respectively, each report one case. In reporting his case Costa gave an excellent review of the literature, and collected 73 cases.

More recently Wahl and Gard¹³ collected those cases reported since the publication of Posselt's¹⁰ summary.

In the existing material it is found that a great majority (85 per cent) of the aneurysms involve the main trunk, and most of the remaining involve the major branches. Less than 10 per cent of the entire group involve the smaller branches, and it is to this latter group that we wish to add one case.

CASE REPORT

Female, aged fifty. Father died of chronic alcoholism at the age of forty-seven. Mother died of coronary thrombosis at the age of sixty-eight. One brother died a cardiac death at the age of forty-two. Three sisters living and well.

The patient was first seen because of severe anemia which apparently resulted from recurrent epistaxis. Nosebleeds had first made their appearance at the age of thirty-nine, and continued off and on until the patient's death. At one time the anemia became so marked that transfusion was found necessary. The hemorrhages resulted from ulcerations of the nasal septum associated with delay in formation and retraction of the clot.

At the age of forty-nine, the patient suffered a cerebral vascular accident from which she

recovered, except for the loss of accommodation of the left eye and accompanying diplopia.

Following this episode she was apparently well for six months, at which time gastric distress developed. This was most marked after eating and was accompanied by nausea, occasional vomiting, occult blood in the stools and steady drop in hemoglobin, from 72 per cent to 49 per cent (Dare) within two weeks. Increasing dyspnea and tachycardia were present during this period. It was at this stage of the illness, November 12, 1931, that the patient consented to enter the hospital for further study and observation.

Physical examination on entrance revealed a frail, pallid woman whose sclerae and skin gave a suggestion of a subicteric tint. Aside from the loss of accommodation in the left eye, examination of the head was negative.

The heart sounds were soft, pulse rapid and soft. Both sides of the chest showed evidence of a small pleural effusion.

The abdomen was scaphoid, no masses were felt. The extremities were negative aside from moderate wasting and loss of muscular tonicity. Electrocardiographic studies by Dr. Roy G. Pfozter revealed a simple tachycardia. Blood studies revealed the picture of a secondary anemia. Urinary findings were normal. Stools gave strong occult blood reactions. The Wassermann and Kahn reactions were negative.

A roentgen examination of the chest revealed the appearance shown in Figure 1. The conclusion at this time was that the patient showed evidence of metastatic pulmonary malignancy with accompanying small bilateral effusion.

It was felt that a search for the primary lesion should begin with the gastrointestinal tract. Plans were accordingly made for a gastrointestinal study on the following day. However, on the afternoon of admission, and before any further examination could be completed, the patient developed symptoms of coronary thrombosis: intense precordial pain, extreme apprehension, a sharply falling diastolic pressure, oliguria and albuminuria.

During the following three days the diastolic

*From the X-Ray Department of the Millard Fillmore Hospital, Buffalo.

pressure dropped from 100 to 40 mm. Hg. On the fourth day the patient suffered an exacerbation of her symptoms and died.

An autopsy was performed three hours after death by Dr. Margaret Warwick.

The body was that of a well-developed, but very poorly nourished adult, middle-aged female. Pathologic lesions were found only in the

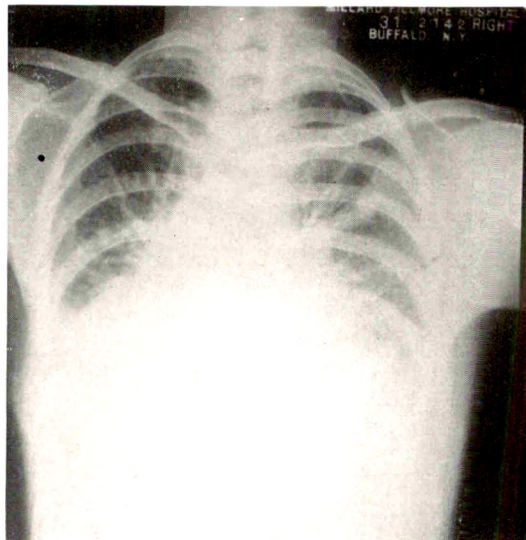


FIG. 1. The presence of rounded shadows in the right upper lung field and evidence of bilateral pleural effusion led to a diagnosis of pulmonary metastases.

lungs, pleura and heart. The head was not opened. All other parts of the body showed nothing of interest.

As soon as the left pleural cavity was opened, there was a gush of blood from between the cut ribs, as if the cavity were filled with fluid blood under pressure. In the lower part of the cavity were several large masses of dark, clotted blood. In the base of the lung was a dark-colored, rounded mass measuring about 5 cm. in diameter and bound to the upper side of the diaphragm by very firm, fibrous adhesions which were broken with difficulty, and which served to form a firm connection between the lung and the diaphragm. In one side of this mass there was a laceration from which protruded large pieces of clotted blood. This evidently represented the source of the blood in the pleural cavity but, at the time of death, the opening was effectively plugged by blood clots. This mass seemed to arise from the substance of the lung, and must have been present

for some time to have been so firmly adherent to the diaphragm.

The left lung was slightly smaller than usual and without the usual content of air. It appears to have been definitely compressed by the pressure of the blood in the pleural cavity. The mass in the base was found to consist of a thin-walled sac filled with both fluid and clotted blood, arising from the lung tissue which surrounded it on one side, and on the other bound tightly to the diaphragm by firm fibrous adhesions. In one side was a rent measuring about 3 cm. in length and effectively plugged by large blood clots. The inner surface was smooth and shining and with no clotted blood adherent to the wall, suggesting that the clots, which it contained, were of recent formation, not later than the time of death. Leading out of the upper side of the sac was a small artery, which proved to be a branch of the pulmonary artery. Contrary to the usual appearance, this small artery was slightly wider at the periphery of the lung than at the hilus. At its junction with the sac, it enlarged very abruptly and became the sac. It was evident, then, that this was an aneurysm of one of the branches of the pulmonary artery, which was situated in the periphery of the lung and which must have gradually increased in size until it finally ruptured and caused a fatal hemorrhage into the pleural cavity. That this rupture was deferred as long as it was, was probably due to the protection of the diaphragm which limited its outward expansion and, by the formation of adhesions, kept it firmly fixed and immobile. Microscopic sections show only a very thin arterial wall with no adherent clotted blood. The small arteriole branches, which were in the surrounding lung tissue, were larger than usual and moderately tortuous, but the walls were not thinner than usual. The remainder of the lung showed nothing of interest.

In the right pleural cavity there was a large amount of clear, straw-colored fluid but no adhesions were found. In the right lung there was nothing of interest except in the upper branches of the pulmonary artery. Here in the upper lobe were several small dilatations of the arterial walls, measuring up to 2 cm. in diameter. These were all filled with clotted blood which was easily shelled out, leaving smooth, shining surfaces. These were evidently tiny aneurysms of the vessel similar to the one found in the base of the left lung, but better protected from dan-

Increased pulmonary pressure associated with a congenital defect in the vessel wall may be the explanation. The cases reported by Churton and by Wilkens both represented congenital heart lesions of sufficient severity to account for increased pulmonary pressure.

The pathological anatomy of the condition was clearly described in the first report which we have found.

"Mr. Fern of Derby has recorded (*Lancet*, February 6, 1848) the case of a patient who died from hemoptysis in whom an aneurysmal sac the size of a nutmeg was found jutting into a tubular extremity on the upper lobe of the left lung. The parietes of the sac were thin and did not contain any fibrinous layers, a vessel the size of a crow quill leading from a considerable trunk of the pulmonary artery was distinctly traceable into the sac."

A clinical syndrome is rather difficult to construct from the small group of reported cases. The patients are usually young and show a tendency to bleeding from the nasal or oral mucous membranes. An associated heart lesion may be present. Epistaxis or hemoptysis leads to anemia which, as in our case, may become quite severe, and superimposed infection would add its accompaniments of chills, fever and leucocytosis. Death results either from hemorrhage or infection.

The duration of the condition is not definitely known. Wilkens' case was followed over a period of six years.

The condition should certainly be differentiated both clinically and pathologically from the more common aneurysms of the main trunk and major branches. This latter group has a fairly definite symptomatology of heart disease often with polycythemia and a mediastinal tumor which produces varying degrees of pressure symptoms or is visualized in the roentgen examination.

DIAGNOSIS

The rarity of peripheral aneurysms militates against their clinical recognition, first,

because they are rarely, if ever, thought of, and second, because of the lack of a firmly established symptomatology. Three of the cases which we have encountered have had roentgen studies made.

In the case of Sherman and Roman the roentgen findings were indeterminate. In Wilkens' case the findings were interpreted as tuberculosis, while in the case which we present the findings were interpreted as pulmonary metastases.

A review of the films with the post-mortem findings in mind make it clear that such an error may be avoided in the future. A close study of Figure 1 will show that each of the rounded densities in the upper right lung field shows a definite vascular connection with the hilus. This is the one characteristic differentiating point.

Roentgenoscopic examination might or might not reveal pulsation in the sacs, depending on their size and the state of their contents.

Failing to demonstrate these vascular connections one would be forced to a consideration of: pulmonary metastases, hydatid cysts, discrete tuberculous deposits, gummatous pulmonary lesions or the unusual multiple nodular type of primary pulmonary carcinoma.

The differentiation on combined roentgenographic and clinical grounds should not be difficult if the possibility of the condition is kept in mind.

SUMMARY

A case of multiple aneurysms of the terminal branches of the pulmonary artery has been presented. A brief review of the literature reveals that such dilatations may arise either as mycotic aneurysms or upon the basis of congenital defects. The case presented falls in this latter group. It is felt that these types of aneurysms should be differentiated from those involving the major trunks. An attempt is made to clarify a somewhat indefinite symptomatology and a differential point in roentgenographic diagnosis is mentioned.

REFERENCES

1. ARRILLAGA, F. C. Aneurysm of the pulmonary artery with cyanosis of the face ("black cardiacs"). *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1924, 48, 1230-1235.
2. BEATTIE, J. M., and HALL, A. J. Multiple aneurysms of the pulmonary arteries following thrombosis of the veins of leg. Death from rupture of aneurysm into the lung. *Proc. Roy. Soc. Med.*, 1911-1912, 5 (*Path. Sect.*), 147.
3. CHURTON, H. Multiple aneurysms of the pulmonary artery. *Brit. M. J.*, 1897, 1223.
4. COSTA, A. Morfologia e patogenesi degli aneurismi dell'arteria polmonare. *Arch. di pat. et clin. med.*, 1929, 8, 257-292.
5. FERN. Quoted by Chevers, N. *Lond. Med. Gaz.*, 1848, 42.
6. HUMPHRY, L. Multiple embolic aneurysms of the pulmonary artery. *J. Path. & Bacteriol.*, 1912-1913, 17, 212-216.
7. LECONTE, M., and BORDET, E. Aneurysm of the pulmonary artery. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1924, 48, 353-358.
8. LOVELAND, B. C. Aneurism of the pulmonary artery. *Med. Rec.*, 1901, 59, 349-351.
9. MOENCH, G. L. Aneurysmal dilatation of the pulmonary artery with patent ductus arteriosus. *J. Am. M. Ass.*, 1924, 82, 1672-1673.
10. POSSELT, A. Die Erkrankungen der Lungen-schlagader. *Ergebn. d. allg. Path. u. path. Anat.*, 1909, 13, 298-526.
11. SHERMAN, D. H., and ROMAN, B. A case of multiple aneurysms of the branches of the pulmonary artery. *Buffalo Gen. Hosp. Bull.*, 1926, Vol. 4.
12. TREVOR, R. S. A case of multiple mycotic aneurysms of the branches of the pulmonary artery within the lung. *Proc. Roy. Soc. Med.*, 1911-1912, 5, (*Path. Sect.*), 155-158.
13. WAHL, H. R., and GARD, RAYMOND L. Aneurism of the pulmonary artery. *Surg., Gynec. & Obst.*, 1931, 52, 1129-1135.
14. WARTHIN, A. S. Syphilis of the pulmonary artery. *Am. J. Syph.*, 1917, 1, 693.
15. WILKENS, G. D. A case of multiple pulmonary aneurysms. *Beitr. z. Klin. d. Tuberk.*, 1917, 38, 1-10.



THE TYPE AND LOCATION OF ROENTGEN SHADOWS IN THE DIAGNOSIS OF CHRONIC PULMONARY TUBERCULOSIS

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THE roentgenologist in most instances makes a correct diagnosis of pulmonary tuberculosis as checked by clinical and necropsy findings. In fact, he is often the first to detect the disease. This accuracy in diagnosis exists despite the fact that roentgenologists disagree in their appraisal of the shadows. Some hold that the shadows are pathognomonic, others that they are characteristic, and still others that they are merely suggestive of the disease, while only a few briefly refer to their location as an aid in diagnosis. We shall attempt to evaluate these conflicting views because they lessen the clinical value of the roentgen ray and are confusing to the student.

TYPE OF SHADOW IN DIAGNOSIS

Cole,¹ one of the earlier authorities, says:

I do not claim to show the microscopic (tubercles). But it is the intermediate tubercles, the smallest ones that are clearly discernible by the naked eye on cross section . . . that show distinctly in a radiogram having sufficient detail. It is on these tubercles that the positive diagnosis of incipient pulmonary tuberculosis by the x-rays depends.

Manges² in discussion states:

I do not care what the stage of the disease, except the very, very early stage, or when exudation is excessive, you can always recognize the tubercle shadows, and that shadow is essential to the diagnosis of pulmonary tuberculosis. It does not matter whether the tubercles are discrete or confluent; whether they involve a part or the whole of a lobe.

Dunham³ is equally definite:

It is the characteristic densities of a fan that are pathognomonic of tuberculosis and not the fan itself.

Caulfeild and Richards³ define first degree minimal involvement in the following words:

. . . lessened radiability as shown in the form of light mottling, haziness or flocculent opacities, confined to one area or a cluster of contiguous areas not exceeding one inch in cross section. This is intended to represent the smallest lesion which can be positively identified as a definite tuberculous lesion.

Kraetzer⁶ commits himself as follows:

. . . suffice it to say that the only pathognomonic x-ray sign of early tuberculosis is the characteristic shadow of parenchymatous infiltration.

If the mottled shadows of tuberculosis were characteristic, one should be able to differentiate them from the mottled shadows of chronic non-tuberculous infections. The two are indistinguishable, for the mottled shadows of the chronic non-tuberculous infections confined to the upper third of the lung field are erroneously interpreted as tuberculosis, and conversely, the mottled shadows of tuberculosis when confined to the lower third are confused with those of the chronic non-tuberculous infections.

Dunham⁵ discussing basal lesions says:

They are very difficult to diagnose and I always wait for the bacilli to be found before making a definite diagnosis.

We, too, were unable to distinguish the mottled shadows of tuberculosis from those of chronic non-tuberculous infections in a series of 74 cases, 31 proved tuberculous and 43 non-tuberculous, where the disease was unilateral and confined to the lower third of the lung. In 20 cases of chronic pulmonary tuberculosis and 6 cases of chronic non-tuberculous infections coming to necropsy, we attempted to correlate the lesions with their respective shadows. Roentgenograms were taken frequently during the course of the disease, and after

death with the lungs in situ and after they were removed from the body and inflated. We found no appreciable difference between the mottled shadows of tuberculosis and those of the chronic non-tuberculous infections, even by the aid of a magnifying glass.

Miliary tuberculosis affords the crucial test to determine whether the shadows are pathognomonic. Here the mottling is fine, discrete and sharply defined and presents optimal conditions for the interpretation of underlying pathological changes. Yet the shadows of miliary tuberculosis cannot be differentiated from those of miliary carcinoma or miliary silicosis.

The histological character of the tuberculous lesion does not vary with its position in the lung. The claims of certain observers that the shadows are characteristic in one part of the lung field and not in another is a tacit admission that they are not characteristic.

The pathologist frequently cannot differentiate chronic pulmonary diseases on macroscopic examination. It is therefore even less likely that the roentgenologist should do so from a study of their shadows for they merely represent airless portions of the lung resulting from disease or atelectasis.

In previous communications^{1,2} attention was directed to the mutation of pulmonary shadows incident to the type of respiration. On costal breathing the shadows may appear mottled and on diaphragmatic breathing the same shadows may be homogeneous, additional evidence that tuberculous lesions do not cast distinctive shadows.

LOCATION OF SHADOWS IN DIAGNOSIS

Clinical and necropsy studies in adults reveal that tuberculosis is responsible for at least 90 per cent of all chronic lesions localized in the upper third of the lung. The incidence is higher when the lesion is confined to the apex of one lung, and still higher (practically without exception) when limited to the apices of both lungs. Conversely, the incidence of non-tuberculous

lesions in the lower third of the lung is more than 90 per cent and when the lesions are confined to the bases of both lungs they are almost invariably non-tuberculous. Tuberculous lesions localized in this region are uncommon; even among patients in sanatoria the incidence is less than 3 per cent.*

The site of predilection of these diseases adequately explains the accuracy of roentgen diagnosis. Thus the probable diagnosis is tuberculosis when the shadows, irrespective of type, are confined to the upper third of the lung field, and non-tuberculous infection when confined to the lower third. Tuberculosis will almost invariably be the correct diagnosis when the shadows are limited to the summit of both lung fields, and non-tuberculous disease when confined to the bases of both lung fields. In those relatively rare instances where the non-tuberculous infections are confined to the upper third of the lung, their mottled shadows are usually mistaken for those of tuberculosis. Location and the lack of distinctive shadows are unquestionably the source of error. The same holds true for tuberculous lesions when confined to the lower third of the lung.

The central third of the lung is common ground for tuberculosis and the non-tuberculous infections, the former predominating, more particularly when bilateral.* Consequently in this region there will be numerous errors in roentgen diagnosis based solely on location. That the type of shadow does not reduce the number of errors refutes the theory of characteristic shadows.

The roentgen diagnosis of tuberculosis in young children is admittedly more difficult than in adults, although the shadows are the same in both instances. The difficulty may be attributed to the fact that in children there is no site of predilection for the disease.

* So far as we can determine, there are no available statistics in regard to the incidence of tuberculous and non-tuberculous disease in the central and lower third of the lung. The percentages here given are approximate and based on studies at the Ray Brook Sanatorium and at the Cornell Medical Division of Bellevue Hospital.

The uniform distribution of the mottling throughout both lung fields in miliary tuberculosis eliminates location as a diagnostic aid. Here the diagnosis rests solely on the type of shadow, which is as typical as any to be found in tuberculosis. That the shadows fail to identify the condition should be conclusive proof that they are not pathognomonic.

Even where the shadows are more or less widely distributed in one or both lung fields, the roentgenologist often makes the correct diagnosis from impressions which he bases on experience, but cannot definitely define. We have analyzed many of these interpretations and have concluded that the underlying factor is location. Apparently his aim is to determine the site of the initial clinical lesion, and he often argues that this lesion originated where the shadows are most dense and numerous and makes his diagnosis on this information.

No claim is made that the shadows indicative of antrum formation are characteristic of tuberculosis, yet in diagnosis they are as important as the moderately coarse and fine mottling. Their significance, like that of the mottled shadows, depends not on their type, but on their location.

Our studies indicate that the roentgen shadows in pulmonary tuberculosis are not distinctive. The view that they are characteristic may result in the disregard of other valuable procedures and lead to unnecessary errors in diagnosis. This view is also largely responsible for the confusion in roentgen diagnosis and supports the prevailing idea that the subject is difficult.

The basis of the roentgen diagnosis of pulmonary tuberculosis is the location of the shadows. This is attested by the definite correlation between the accuracy of roentgen diagnosis and the location of the shadows, and students so instructed readily master the subject.

REFERENCES

1. BRAY, H. A. Mutation of pulmonary shadows due to type of breathing. *AM. J. ROENTGENOL.*, 1922, 9, 628-631.
2. BRAY, H. A. Further remarks on mutation of pulmonary shadows due to type of breathing. *Am. Rev. Tuberc.*, 1925, 10, 649-655.
3. CAULFEILD, A. H. W., and RICHARDS, G. E. The systematic study and classification of stereograms of the chest. *Canad. M. J.*, 1927, 17, 794-797.
4. COLE, L. G. The radiographic diagnosis and classification of early pulmonary tuberculosis. *Am. J. M. Sc.*, 1910, 140, 29-53.
5. DUNHAM, H. K. X-ray examination of the chest and an x-ray classification of pulmonary tuberculosis. *AM. J. ROENTGENOL.*, 1921, 8, 427-444.
6. KRAETZER, A. F. Procedure in examination of the lungs. Oxford Medical publications, 1930.
7. MANGES, W. F. Discussion of paper by Dunham, H. K. *AM. J. ROENTGENOL.*, 1917, 4, 289-290.



THE CLINICAL, ROENTGENOLOGICAL AND OPERATIVE FINDINGS IN 158 CASES OF MASTOIDITIS*

A DESCRIPTION OF A NEW SIGN OF EARLY CELL NECROSIS

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MANY cases of mastoiditis have been reported, operative and roentgenological technique described, and findings, treatment and prognosis dwelt upon. This study of the comparison of clinical, roentgenological and operative findings was undertaken to determine the significance of the various clinical findings in terms of the pathology present and the value and accuracy of the roentgenographic examination. This paper is a report of 158 cases of mastoiditis which have come to operation within a short time after being roentgenographed and in which we have complete data in regard to the clinical and operative findings.

The incidence and severity of mastoiditis seemed to be in direct ratio to the primary infection. In the spring of 1929 we saw a series of cases following an influenza epidemic. These cases did not present the fulminating type of mastoiditis, but a large percentage required surgery. In the winter of 1933, following another epidemic of influenza, we again saw a large number of cases of mastoiditis. A greater percentage of these required operation than in the former epidemic. Also, these cases were of a rapidly developing type. Even in cases seen with an early otitis media in which vigorous treatment was instituted, the majority went on to a mastoiditis requiring surgery.

Mastoidectomy was performed upon patients who presented the usual clinical signs of mastoiditis and roentgen findings of cellular necrosis. Cases that presented the usual clinical and laboratory findings of mastoiditis in which the roentgen examination showed opacity of the cells, but not cellular necrosis, were usually given expectant treatment. If the laboratory and

clinical findings did not abate, the patients were usually operated on whether re-examination showed cellular necrosis or not. Often roentgenograms taken twenty-four to forty-eight hours after the original films would show necrosis of the cells. In the cases of the fulminating type mastoidectomy was performed even if the roentgenograms failed to show cellular necrosis, and frequently necrosis was found at operation.

Of the 158 cases, 131 were operated on within twenty-four hours after taking the roentgenogram; in 14 cases one day intervened between the roentgenographic examination and the operation; in 7 cases two days; in 6 cases three days; and, in one case of chronic mastoiditis showing cell destruction on the film and at operation, there was an interval of thirteen days.

The age incidence in this group is brought out by the following tabulation:

3 to 6 months.....	3
6 to 9 months.....	3
9 to 12 months.....	3
12 to 15 months.....	6
15 to 18 months.....	4
1½ to 3 years.....	4
3 to 6 years.....	21
6 to 10 years.....	30
10 to 15 years.....	13
15 to 20 years.....	18
20 to 30 years.....	28
30 to 40 years.....	10
40 to 50 years.....	9
50 to 60 years.....	3
60 to 70 years.....	3

There were 75 males and 83 females. The right ear was affected in 83 of the cases and the left in 75. It will be noted that the side involved and the incidence of males and females affected were about equal. The greatest number of cases were in the groups under ten years of age.

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The majority of the cases in our series were of acute mastoiditis. The type of mastoiditis and associated complications are shown by the following table:

Acute.....	147
(with nephritis—2	
(with multiple sclerosis—1	
Acute complicated	
With fracture skull.....	1
With cerebellar abscess.....	2
Lateral sinus thrombosis.....	7
Subacute.....	2
Chronic.....	6
(with cerebral abscess and	
meningitis—1	

In general, the duration of the symptoms of mastoiditis obtained from the history of the patients or relatives was short, mostly under one week and the vast majority under two weeks. In considering the duration of the symptoms, we do not mean the prodromal symptoms or the presence of otitis media, but as nearly as can be determined the time of the actual existence of the mastoiditis.

The characteristic symptoms of mastoiditis were present in practically all of the cases. Protrusion of the auricle was evident in 37 of the cases, due either to edema or subperiosteal abscess formation, or both. Pain over the mastoid was complained of in 134 of the cases. Tenderness was also a rather constant factor, being present over the entire process in 123 cases, the antrum in 20, the tip in 15 and the zygoma in 2. Edema, although less common than might be expected, was present over the process in 90 cases and over the zygomatic region in 4. This sign is not infallible and when apparently present, gland enlargement due to furunculosis, scalp infection, otitis media, or other causes must be excluded. Here the roentgen examination plays a valuable part. Edema or sagging of the auricular canal was found in 41 cases. This drooping was uniformly a helpful sign, the most difficult differential point being the complication of furunculosis of the canal.

Albuminuria was of fairly frequent oc-

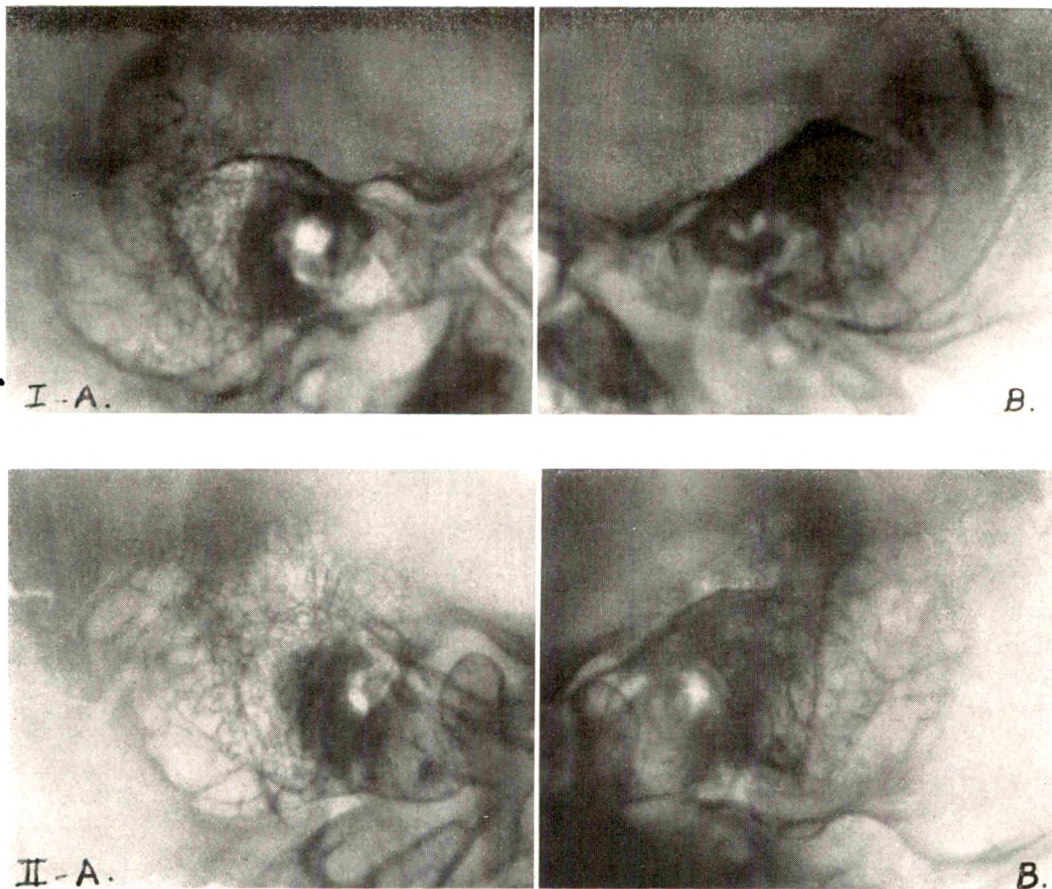
currence and usually cleared up after intervention on the mastoid.

Cultures were taken from the mastoid at the time of the operation in all but 38 cases. For accuracy in reports it would seem that smear and culture from the ear when otitis is present plus a mastoid culture at the time of the operation would give added information, and such procedure has been done in some of the later cases. The cultures are valuable in noting the type of infection, particularly during epidemics following such diseases as measles, scarlet fever or influenza, and also when subsequent blood stream infection takes place. The following table shows the types of organisms in the order of their frequency:

Streptococcus.....	55
Streptococcus and staphylococcus.....	2
Streptococcus and pneumococcus.....	1
Pneumococcus.....	22
No growth.....	16
Staphylococcus.....	12
Diplococcus and bacillus.....	11
<i>Micrococcus catarrhalis</i>	1

Three deaths, a mortality rate of 1.9 per cent, occurred among these 158 cases, 2 of which were due to lateral sinus thrombosis and one to cerebellar abscess. The latter patient had a left mastoidectomy. Twenty days after being dismissed from the hospital he returned and a diagnosis of brain abscess was made. Craniotomy was performed, but the patient died four days later. Autopsy showed a cerebellar abscess of the left side. The other two deaths were due to lateral sinus thrombosis with septicemia. The second of these patients had been dismissed following the mastoidectomy. She returned eighteen days later with a lateral sinus thrombosis and died in five days.

The 7 cases of lateral sinus thrombosis presented the more or less typical signs of this complication. When the prodromal symptoms of toxicity, chills, septic rise in temperature, and other signs point to a lateral sinus infection, operative procedure should be instituted early. Ligation of the



FIGS. 1, 2, 3 and 4. Roentgenograms showing the sign of early cell necrosis. Those marked A are the normal sides for comparison with the affected sides labelled B. Note in the involved sides (B) that the cell outlines appear slightly widened, density of cell wall appears to be increased, edge of cell wall shows a fine

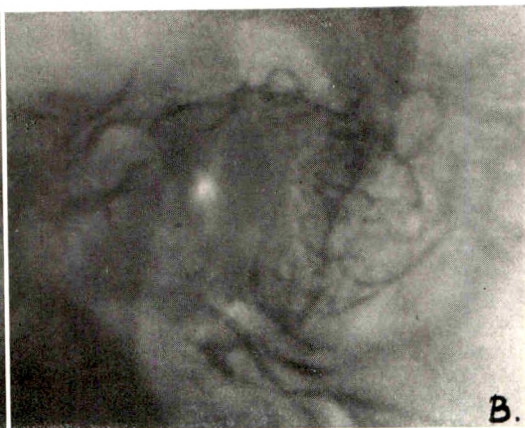
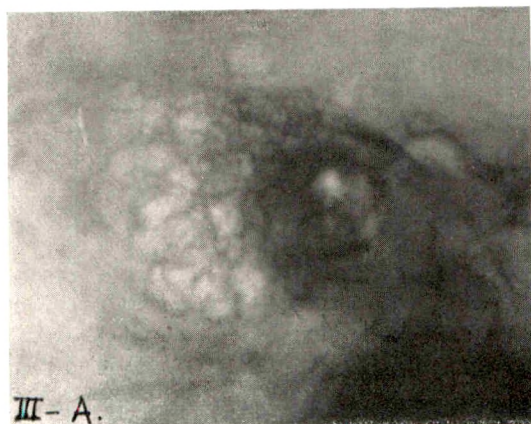
jugular vein and opening of the sinus was the procedure used. The value of early and repeated blood transfusions in cases of lateral sinus infection and septicemia cannot be overestimated. The patients in this series were given the combined surgical treatment plus the transfusions.

The roentgenogram cannot indicate lateral sinus infection or thrombosis, but it is most valuable in sinus location prior to mastoidectomy. Then, during the operation the sinus wall can be well outlined in bony contour, thus making operative procedure easier later on if a sinus infection should develop and exposure become necessary.

Bilateral stereoscopic films in the Law

position were the views taken routinely. In the presence of an otitis externa, complicating furunculosis of the canal, where there was a question of mastoid involvement, and in which the Law position showed only a diffuse haziness, views in the Granger-Arcelin position were also made. The best detail possible was obtained by using a tube with an extremely fine focal spot and the smallest cone possible. The Potter-Bucky diaphragm was employed except in cases of infants and small children where a rapid technique was required.

In studying the films the following points were noted especially, and reported to the surgeon:



fuzziness, but that the cell wall can be traced out completely, or at least could be in the original films. At operation these cases all showed necrosis of the cell walls.

1. *The type of mastoid*—whether infantile or adult. There were 130 adult and 28 infantile.

2. *The size of the cells, any unusual location of cells, and the presence of zygomatic cells.* The majority of the cases contained medium-sized cells. In the 28 cases with infantile type of mastoid, 14 were of the diploic type, the ages being:

Under 6 months.....	2
6 to 12 months.....	5
12 to 18 months.....	2
18 months to 5 years.....	5

There were 14 cases of the infantile type with small cells, the ages of the patients being:

Under 6 months.....	1
6 to 12 months.....	2

1 to 3 years.....	10
24 years.....	1

Zygomatic cells were seen on the films in 20 of the cases.

3. *The presence and degree of opacity in the mastoid antrum and cells.* There was a marked degree of opacity of the antrum and some of the cells in all but 3 in this group, pus being present in the antrum and part of the cells at operation. In 3 patients, aged four, eight and eleven months, with an infantile diploic type of mastoid, no change was discernible on comparing the two sides, but pus was found at operation. Even in these 3 cases the films were valuable in that they showed the location of the sinus. However, in the other 6 cases under one year of age definite changes were

shown by roentgenograms and confirmed at operation.

4. *Evidence of cell necrosis.* Cell necrosis was reported (a) if the cell walls could not be traced out in their entirety in studying the stereo films and comparing the two sides, (b) whenever the new sign of early cell necrosis, described later in this paper, was present, (c) in the presence of a positive Granger sign. In reporting necrosis the mastoid cells were divided into four groups: periantral cells; upper half of mastoid; lower half of mastoid; and zygomatic or unusual extension of the cells.

(a) *Definite cell necrosis.* One or more groups of cell walls appeared definitely necrotic on the films in 113 of the cases; 112 of these showed necrosis at operation.

Of the 20 cases showing zygomatic cells, the youngest patient being three years of age, 9 showed necrosis of these cells on the films and at operation, and one showed only opacity of the cells, but early necrosis was present at the time of the surgery two days later.

(b) *A new sign of early cell necrosis.* About three years ago in checking the surgical findings and the mastoid films immediately after the operation, it was noted that cases not showing frank cellular necrosis roentgenologically, but in which the cell walls showed the following roentgen changes, were necrotic:

(1) Cell wall would appear to be slightly widened.

(2) Density of the cell wall seemed to be slightly increased.

(3) Edge of the cell wall would show a fine fuzziness.

(4) Cell walls, however, could be traced out completely.

Since that time this sign has been carefully looked for and in this series there were 11 cases that showed the four findings of this sign in the cell walls. Ten of these showed necrosis of the cell walls at operation. In the other case the cells contained pus and the cell walls appeared to be intact (Figs. 1, 2, 3 and 4).

(c) *Granger's sign.* Four patients, aged three, eleven, seventeen and twenty-four months, showed the sign described by Granger, that is, the sinus plate could be clearly seen on the affected side and could not be visualized on the normal side. These cases showed extensive necrosis of the cells down to and involving the sinus plate at operation.

In 20 cases the cells appeared opaque and the cell walls appeared normal on the films, but at operation they showed necrosis. In 3 only a slight amount of necrosis was present around the antrum. It must be remembered that this series contains only operated mastoids. There were a large number of cases seen during this period showing opacity of the cells, but no evidence of cell destruction, and these patients made uneventful recoveries without operation.

We made a roentgenographic diagnosis of cell necrosis in 128 cases, the diagnosis being based on definite loss of cell outline in 113, on the new sign of cell necrosis in 11, and on Granger's sign in 4 cases. One hundred and twenty-six of these showed necrosis at operation. Twenty cases did not show evidence of cell necrosis on the films, but did at the time of the mastoidectomy.

5. *The position of the lateral sinus.* After a discussion with the otologist, it was decided to report in all mastoids the position of the sinus in regard to its relationship to the antrum and also in regard to its depth from the cortex. It was reported as anterior if it was in very close proximity to the antrum, as median if it passed through the middle of the mastoid process, and posterior if it was in the posterior part of the mastoid process. It was reported as superficial if it was just under the cortex, of medium depth if one or two layers of cells intervened between the sinus and the cortex, and as deep if it was located along the inner border of the mastoid.

The location of the lateral sinus in this series was as follows:

of their maturity makes it difficult to accept this view.

The frequent occurrence of these defects was used by Kassowitz also as an argument in favor of his opinion that fetal rickets is not an uncommon occurrence, for he believed that the basic factor in these cases was rickets. Wieland admits that children with this anomaly are just as prone to later development of rickets as are normal children but is emphatic that the two conditions can be sharply distinguished, (1) by time of onset, (2) by location of lesions, and (3) by its effect on the remaining skeletal and muscular systems. His histologic research makes him feel that lacuna skull has nothing whatever to do directly or indirectly with rickets. With this opinion most writers on this subject are in complete accord. Cohn himself feels that this is the most important contribution to the subject made by Wieland.

Second, there is the form of soft or lacuna skull in which are found long, irregular or round depressions in the skull tables. To this type of congenital anomaly Schmidt,¹¹ in 1910, gave the name of "relief skull." Cohn,² Schmidt,¹¹ Faust,⁴ Engstler,³ Wieland,¹⁴ Kato,⁷ and others, have noted that this type is found almost exclusively in conjunction with spina bifida with meningocele or with encephalocele. Our 3 cases were all of this type. Faust notes a special type of physiognomy in these cases, which he describes as a depression of the root of the nose, a protruding upper jaw and an old, matured expression, which he thinks is pathognomonic.

Von Recklinghausen⁹ was the first to call attention to the occurrence of spina bifida and relief—or lacuna—skull in the same patient, and Heubner,⁵ in 1903, also reported a case, with spina bifida and club feet. The skull showed the characteristic changes of relief skull but while the sutures were wide, the circumference of the skull was less than normal—31 cm. Von Recklinghausen's explanation was a simultaneous occurrence of cranial and spinal osse-

ous defects together with a hydrops of the medullary groove, and in this opinion Engstler concurs.

In this type of anomaly, the skull shows digitations corresponding to the brain convolutions and has the roentgenologic appearance of increased intracranial pressure

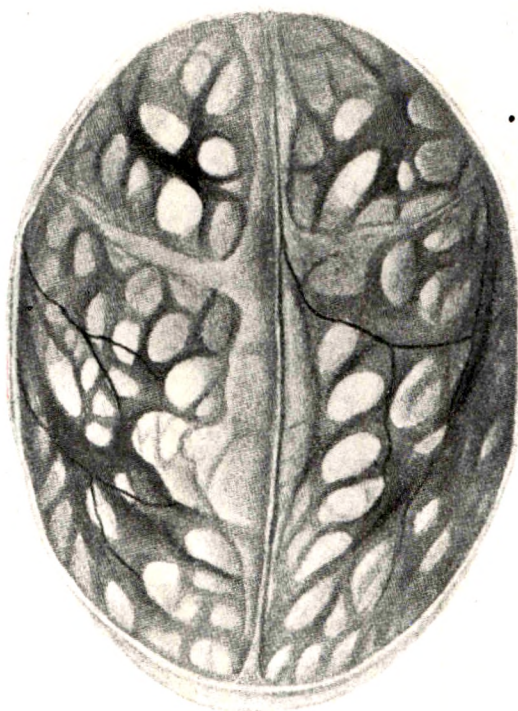


FIG. 1. Drawing of inside of skull of Engstler's Case 6.

except that there is no widening of the sutures or bulging of the fontanelles. In Engstler's case (see Fig. 1) palpation showed a smooth skull but with somewhat enlarged fontanelles. The inside of the skull showed a net-like arrangement of bone growth, which formed arches, between which paper-thin, periosteal, almost membranous, areas appeared. The arches or ridges corresponded, for the most part, with the arterial vessels and were of about normal thickness.

Wieland and Faust explain the findings on the basis of increased intracranial pressure and believe that the encephaloceles and meningoceles that occur are in the

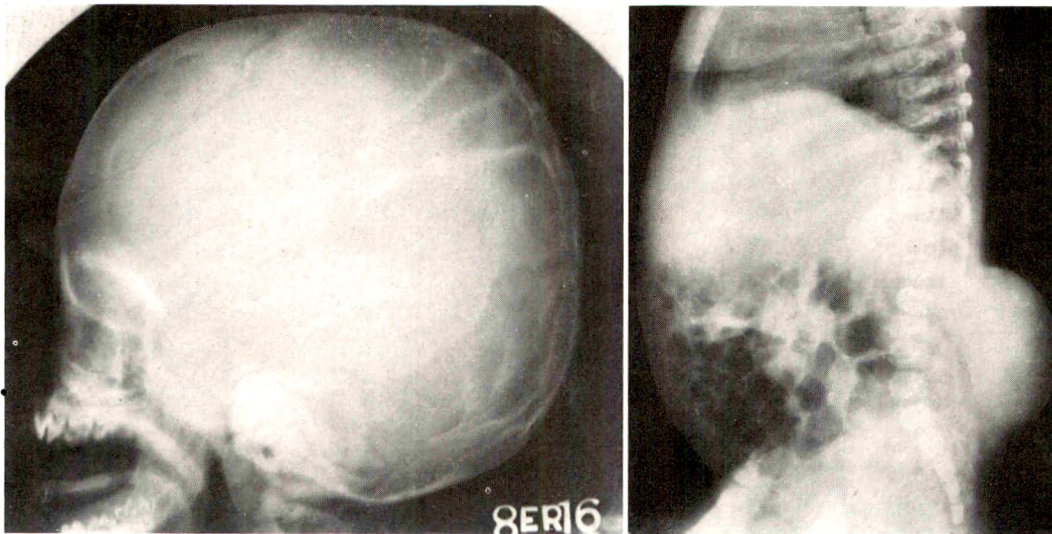


FIG. 2. Case 1. "Relief skull" and spina bifida with meningocele. Sutures open but narrow rather than wide.

nature of growth or pressure "safety valves." Lack of widening of the sutures and bulging of the fontanelles is explained by Faust by the fact that the skull is surrounded by the amniotic fluid which prevents enlargement of the skull in any single direction. Kato and Engstler deny the action of increased intracranial pressure and explain the findings on a basis of maldevelopment per se, as did von Recklinghausen, although von Recklinghausen admitted hydrops of the medullary groove. Cohn, however, doubts if mere mechanical pressure can cause such thinnings and actual holes. He has seen cases in normal, full term infants who had no spinal anomaly or any other evidence of increased intracranial pressure, but these are the cases of delayed development rather than resorption caused by pressure where there are spinal or cranial defects.

Baumm¹ cautions us that these anomalies should not be considered on a basis of osteogenesis imperfecta without the finding of other changes, especially congenital fractures.

In one of Vogt's¹³ cases, even though the head was smaller than normal, there was a marked degree of relief skull, but no definite evidence of increased intracranial pres-

sure. Encephalography after excision of the occipital meningocele showed greatly dilated ventricles with development at this time of considerably increased pressure.

The cases of delayed ossification usually go on to complete healing within three to four months, with normal hardening of the sutures. Those with delayed closure of the parietal fissure or foramen may show either complete ossification or there may be left the "third fontanelle" or a persistent parietal foramen.

In the cases of true relief skull, none has been found without an accompanying meningocele or encephalocele with or without club feet or other signs of disturbance of the lower cord. These cases, almost without exception, have gone on to an early death either from hydrocephalus following surgical attack on the tumor mass, as in Case 1, or from infection of the meningocele. It would be extremely interesting to follow one of these cases which had been operated on by the method recently advocated by Penfield and Cone⁸ in which the sac is folded in and not removed so that its absorbing value is not disturbed. It may be found, however, that they are of the type that goes on to hydrocephalus in spite of such treatment.

CASE REPORTS

CASE I. M. J. K. Patient fifteen days old was brought to the University Hospital, April 10, 1930, because of "lump" over the lower back. This had been present since birth and had gradually increased in size. Examination revealed an ulcerated, raised lesion over third and fourth lumbar vertebrae, evidently a meningocele. Fontanelles seemed tenser than normal. Skull measurements were as follows: occipito-frontal 35 cm., suboccipito-bregmatic 33 cm., and occipito-mental 39 cm. No roentgen examination made at this time. No surgery was advised.

Patient was brought back August 9, 1930, when about four and a half months old, showing beginning hydrocephalus but appearing otherwise well. The skull showed just a suggestion of "steep skull." The posterior fontanelle was closed; the anterior appeared of normal size and showed no increased tension. Examination showed some increase in size of meningocele. Roentgen examination showed spina bifida with meningocele and changes in the skull characteristic of "relief skull" or "Lückenschädel." The fontanelles were not bulging and the sutures were still open but not widened—

rather narrow, in fact (Fig. 2). Operation August 19, 1930, with removal of sac. Following operation patient became rapidly worse with signs and symptoms of increased intracranial pressure and died August 24, 1930.

CASE II. B. J. B. Born November 4, 1931. Breech presentation. Birth weight 3,360 gm., length 51 cm. Diameters of head: Occipito-mental 12.5 cm.; occipito-frontal 11.5 cm.; suboccipito-bregma 9.5 cm. Circumference suboccipito-bregma 34 cm. Lumbosacral meningocele at birth with partial paresis of legs. Two days after birth, a tumor mass the size of a walnut appeared in suboccipital region. This was tense and cystic. Lumbar meningocele began to leak soon, and on December 1, 1931, it ruptured and drained. On December 16, 1931, there were definite convulsions and facial twitchings, which were interpreted as signs of meningitis. The skull showed increasing hydrocephalus.

Roentgen examination two days after birth showed the suboccipital and lumbosacral meningoceles with spina bifida and the changes in the skull which are characteristic of "relief skull" or "Lückenschädel"; the sutures were of normal width and the fontanelles were not bulg-

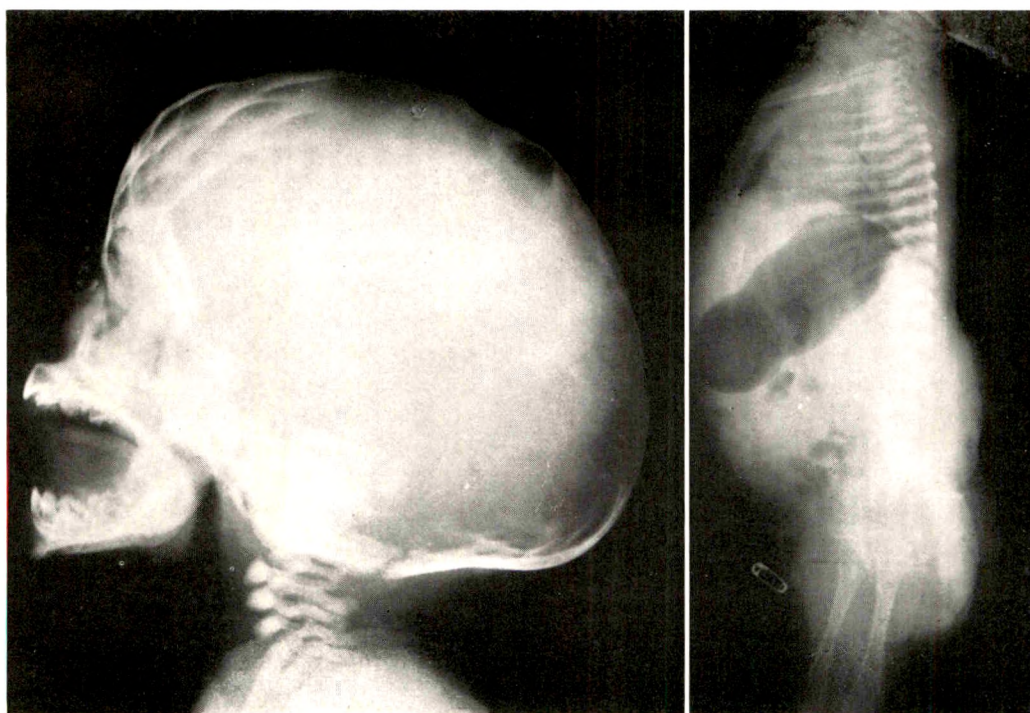


FIG. 3. Case II. "Relief skull"; normal diameters, sutures and fontanelles; spina bifida with meningocele.

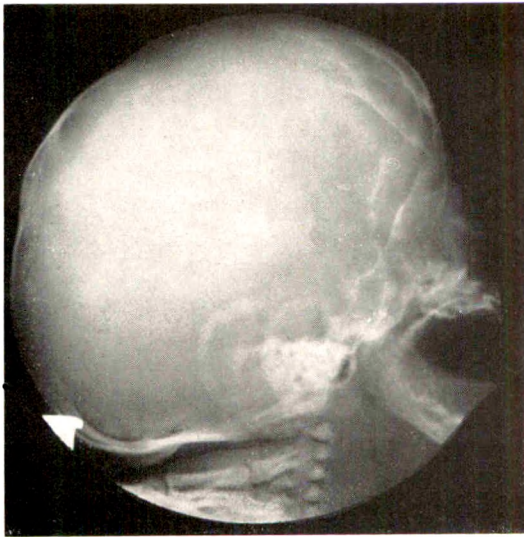


FIG. 4. Case II. After infection, showing hydrocephalus with bulging fontanelle.

ing (Fig. 3). Following the infection, skull began to enlarge rapidly and now shows the changes typical of hydrocephalus (Fig. 4).

CASE III. D. J. Male child seven weeks old, brought to the University Hospital December

24, 1931, because of swelling over lower back. Birth was a normal breech presentation without instrumentation. Child appeared normal except for a red spot over the lower back, but a tumor began to form in this region soon after birth. Examination showed a mass over the lumbar region about 3 in. in diameter at its base, and 1 in. elevation. It was reddened over the top and showed crusting suggestive of dried cerebrospinal fluid. Severe bilateral clubbed feet. Roentgen examination showed lumbar spina bifida and meningocele with skull changes characteristic of "relief skull" or "Lückenschädel." There was, however, not only no widening of the sutures but they appeared definitely narrower than usual, suggesting premature closure (Fig. 5).

COMMENT

That the typical relief skull (Lückenschädel) shows a roentgenologic picture simulating the digital impressions seen in older individuals with increased pressure cannot be doubted. There remains, however, the normal width of sutures, at times small skull (Heubner, Vogt), and flat fon-

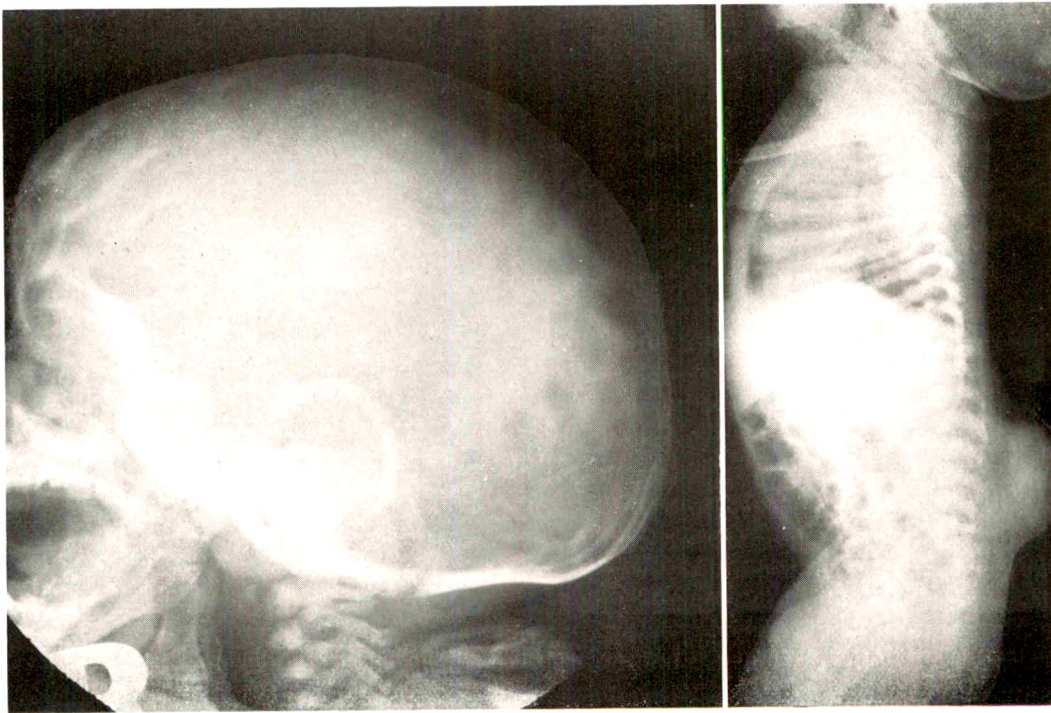


FIG. 5. Case III. "Relief skull" with spina bifida and meningocele. Sutures open but narrow rather than wide.

tanelles to be explained. It must be remembered that while the pressure atrophy on the inner table of the skull is being produced, the entire fetus is enclosed in the amniotic fluid. Selective enlargement of the head, as at the fontanelles is, therefore, almost impossible, and the pressure manifests itself not by general enlargement of the skull, but either by absorption of the overlying bone (or lack of its normal development due to pressure) or by an atrophy of the brain substance through flattening of the convolutions or enlargement of the ventricles, or by the action of both factors. Some molding of the cranial bones is seen in about 50 per cent of the skulls of the new-born, and is probably due to too rapid growth of the brain in the last one or two months of fetal life (Wieland). Wieland and Faust have already spoken of the meningoceles as "safety valves" and this has recently been emphasized by Penfield and Cone. This seems the most plausible explanation for the absence of widened sutures and bulging fontanelles, since after birth the sac seems to be more distensible than the suture lines or fontanelles. With the removal of the meningocele, any case of spina bifida will probably go on to hydrocephalus as has been noted by numerous authors. That this can also follow infection, either spontaneous or after surgical attack, was first shown by West¹⁵ in 1875. Following the second paracentesis of a cervical meningocele in his case, infection set in and the patient rapidly developed hydrocephalus. Death ensued within a short time. At autopsy, the meningeal sac was completely sealed off from the remainder of the cerebrospinal fluid pathways. In relief skull, however, the pressure has already manifested itself in utero in the cranial and cerebral atrophy. The findings in our second case can readily be explained on this basis. Vogt's case seems to be of the same type. In our other two cases, the roentgen findings in the skull suggest that premature closure of the sutures may also be a factor of considerable importance in exaggerating the skull findings after birth (Fig. 2). Engstler's observation that the nor-

mally thick, arched parts of the skull corresponded with the cerebral vessels is what one would expect to find if the changes were due to increased pressure, since the vessels lie in the sulci, between the convolutions.

CONCLUSIONS

1. Three cases of relief or lacuna skull (Lückenschädel) are reported.
2. Its occurrence with meningocele and spina bifida is again emphasized.
3. Its etiology is explained on a basis of intrauterine increased intracranial pressure.
4. This increased pressure may not be manifest after birth because of the safety valve action of the meningeal sac, the cranial and cerebral changes having already occurred, however.
5. The additional factor of premature closure of the cranial sutures is also brought out.

REFERENCES

1. BAUMM, H. Der Weich- und Lückenschädel des Neugeborenen. *Med. Welt.*, 1930, 4, 1239.
2. COHN, M. Zur Lehre vom Weich- und Lückenschädel der Neugeborenen. *Jahrb. d. Kinderh.*, 1924, 56, 333-350.
3. ENGSTLER, G. Ueber den Lückenschädel Neugeborener und seine Beziehung zur Spina bifida. *Arch. f. Kinderh.*, 1904-05, 40, 322-329.
4. FAUST, H. Ueber den angeborenen Relief- und Lückenschädel und seine genetischen Beziehungen zu Spaltbildung im Medullarrohr. *Beitr. z. path. Anat. u. z. allg. Path.*, 1931, 86, 613-632.
5. HEUBNER. Quoted by Engstler, ref. 3.
6. KASSOWITZ. Quoted by Cohn, ref. 2, and by Wieland, ref. 14.
7. KATO, Y. Ueber angeborenen Relief- und Leistenschädel bei Spina bifida und Enzephalozele. *Virchow's Arch. f. path. Anat.*, 1913, 211, 438-455.
8. PENFIELD, W., and CONE, W. V. Spina bifida and cranium bifidum. *J. Am. M. Ass.*, 1932, 98, 454-461.
9. VON RECKLINGHAUSEN, F. Untersuchungen über Spina bifida. *Virchow's Arch. f. path. Anat.*, 1886, 105, 243.
10. SCHAEFFER. Quoted by Cohn, ref. 2.
11. SCHMIDT, M. B. Quoted by Faust, ref. 4.
12. THOMA. Quoted by Cohn, ref. 2.
13. VOGT, E. C. Personal communication.
14. WIELAND, E. Der angeborene Weich- oder Lückenschädel. *Virchow's Arch. f. path. Anat.*, 1909, 197, 167-192.
15. WEST, J. F. Case of meningocele associated with cervical spina bifida. *Lancet*, 1875, 2, 552.

IMPORTANCE OF THE ROENTGEN EXAMINATION IN POLYPOID TUMORS OF THE LARYNX

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IN A previous communication² the roentgen findings in a single case of polyp of the larynx were reported. To date 4 other polypoid tumors of the larynx have been seen at the Cincinnati General Hospital. All were easily outlined on the roentgenogram, and in 2 cases information was obtained from the roentgen examination which could be acquired in no other form of procedure. All of these tumors arose from the anterior wall of the larynx either just above or just below the anterior commissure. Four were benign, one malignant. The ages of the patients ranged from five to sixty years.

Benign tumors of the larynx are probably more common than is ordinarily suspected. In Hay's series of 200 cases upon which he based his monograph,¹ there were 26 benign tumors of the pharynx and larynx. Nine of this number were demonstrated by the roentgen ray. According to Hay, the site of predilection is the vocal cords (16 cases). Other sites of involvement were as follows: epiglottis, epiglottic valculus, anterior commissure, arytenoids, post-pharyngeal wall, aryepiglottic folds, and anterior wall of the laryngeal vestibule.

Polypoid tumors of the larynx can be demonstrated on the roentgenogram when they are so located as to be seen in profile. They are characterized by localized bulgings encroaching on the lumen of the larynx. Roentgenoscopic study gives information as to localized swellings of the soft parts and condition of the laryngeal ventricle. The technique of roentgenography is simple. The patient is placed with his shoulder against the plate changer, head erect and with an assistant steadying the head. The exposure, generally speaking, is that amount of energy required for an

anteroposterior examination of the chest of the patient in question.

Such study of the neck is very valuable in children and uncooperative adults. Two of our cases were quite young—five and six years respectively. Both of the children presented difficulties even in indirect study of the larynx. In fact, in one of the children no visualization of the larynx was done before the patient was taken to the operating room. However, the roentgenogram had confirmed the suspicion of tumor and had given accurate information as to the location and nature of the lesion. A third case was an elderly man who was not at all cooperative. This patient was brought into the Receiving Ward unconscious. It was necessary to do a tracheotomy. Subsequent roentgen examination gave essential information as to the nature of the obstruction.

CASE REPORTS

CASE I. R. P. (No. R-10208), colored male, aged fifteen; chief complaint hoarseness of seven years' duration. This hoarseness had grown progressively worse until the patient could only whisper. There had been no respiratory difficulty. Past history was irrelevant. Physical examination was not unusual with the exception of laryngeal findings which showed numerous small papillomata springing from the anterior wall of the larynx and hanging between the vocal folds and holding them apart.

Roentgen examination—lateral view of the neck (Fig. 1). There is an ovoid mass approximately 1.5 cm. in diameter arising from the anterior wall of the larynx at the level of the fifth cervical vertebra. The laryngeal ventricle is not shown. It is interesting to note that the fact that the mass was made up of numerous small polypi could not be ascertained on the roentgenogram.

CASE II. B. S. (No. 4787), white male, aged six; chief complaint hoarseness and respiratory

difficulty. This child had no symptoms referable to the larynx until four months before admission when he began to lose his voice. Several days prior to admission there had been considerable difficulty in breathing. The general physical examination was negative with the exception of mild respiratory difficulty. Due to lack of cooperation it was impossible to do even an indirect visualization of the larynx.

Roentgen examination—lateral view of the neck (Fig. 2). There is a globular mass arising from the anterior wall of the larynx at the level of the fourth cervical vertebra. The edges of this mass are indistinct and fade off into the surrounding background. Due to this indistinctness in outline it was thought that the tumor must be multiple in character. The laryngeal ventricle was not visualized.

At operation, under direct laryngoscopic vision, multiple small polypi were seen arising from the anterior wall of the larynx just below the cords.

CASE III. R. M. (No. 2968), white male, aged five; entered the hospital complaining of loss of voice. Hoarseness was the initial symptom. On admission the child could barely whisper. There had been occasional choking on swallowing.

Roentgen examination—lateral view of the



FIG. 2. Case II. There is an indefinite tumor mass on the anterior wall of the larynx at the level of the laryngeal ventricle.



FIG. 1. Case I. The tumor mass is outlined arising from the anterior wall of the larynx.



FIG. 3. Case III. Note the localized bulging on the anterior wall.

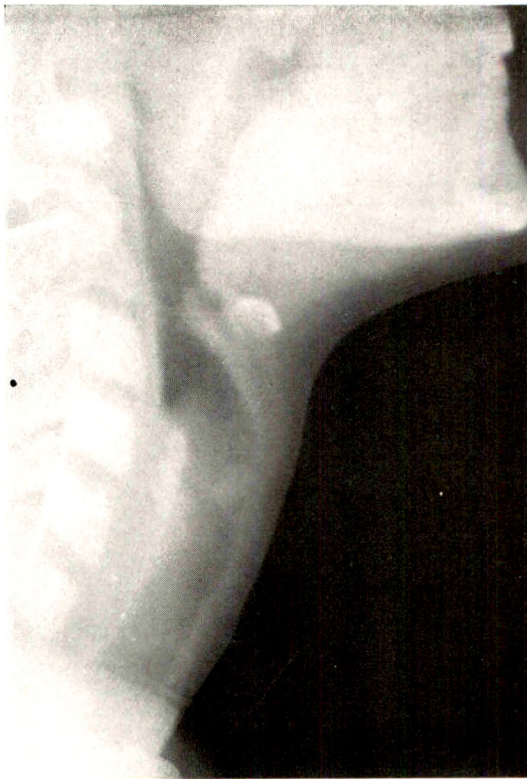


FIG. 4. Case iv. The tumor mass is located just below the anterior commissure. The anterior portion of the laryngeal ventricle is visualized.

neck (Fig. 3). There is a tumor mass approximately 0.5 cm. in diameter arising from the anterior wall of the larynx at the level of the laryngeal ventricle.

Direct laryngoscopic examination disclosed a small growth about the size of a pea situated in the anterior commissure hanging between the vocal cords.

CASE IV. M. D. (No. 5564), white female, aged nineteen; chief complaint hoarseness; onset of present illness two years prior to admission. There had been slight respiratory difficulty with choking spells at night and an irritating cough. Past history was irrelevant. General physical examination was negative.

Indirect laryngoscopic examination showed the epiglottis to be normal. There was a small wart-like growth about the size of a small grape arising just below the anterior commissure.

Roentgen examination—lateral view of the neck (Fig. 4). There is a pedunculated tumor measuring 1×0.25 cm. on the anterior wall of the larynx at the level of the fourth cervical

body. The anterior portion of the laryngeal ventricle is visible above the attachment of the mass.

CASE V. H. G. (No. R-3465), white male, aged sixty. This patient was brought into the Receiving Ward unconscious. His respirations were labored and he was quite cyanotic. Onset of present illness one year before admission, hoarseness with increased respiratory difficulty. Before admission he began to choke, became cyanotic and lapsed into unconsciousness. Physical examination showed a markedly dehydrated white male of about sixty years, very cyanotic, with marked respiratory distress.

Indirect examination of the larynx showed a large tumor mass nearly completely obstructing the larynx. Tracheotomy relieved the respiratory difficulty. Subsequent roentgen examination showed a large pedunculated tumor mass arising from the anterior wall of the larynx and entirely obstructing the lumen (Fig. 5). Biopsy revealed squamous cell carcinoma.

Two stage laryngectomy was done. Examination of the specimen confirmed the roentgen findings. The mass was attached by a pedicle to the anterior wall. Had this fact been considered

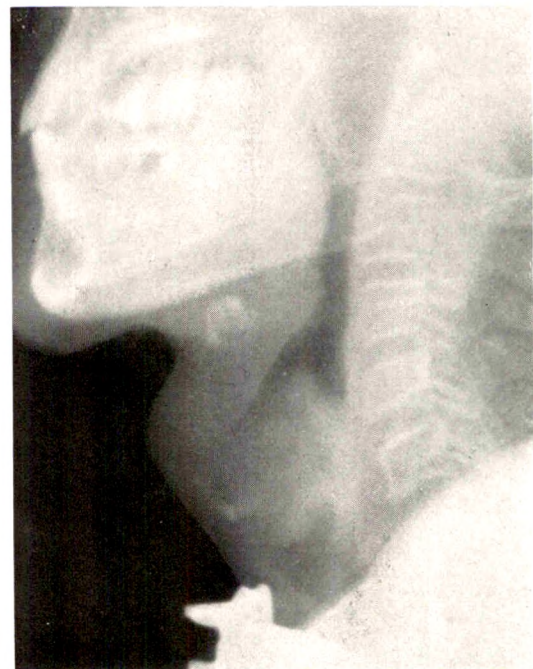


FIG. 5. Case v. The large tumor mass completely obstructs the larynx and is attached by a pedicle to the anterior wall.

a less radical operation would have been performed.

CONCLUSIONS

Polypoid tumors of the larynx can often be visualized with the roentgen ray.

Such examination is especially valuable in children and uncooperative adults.

Roentgen study may give information as to the type of operative procedure to be undertaken.

REFERENCES

1. HAY, P. D., Jr. *The Neck*. (*Ann. Roentgenol.*, Vol. 1X.) Paul B. Hoeber, New York, 1930.
2. McGEHEE, W. H. Epithelial polyp of larynx demonstrated by roentgen ray. *Radiology*, 1932, 19, 60-61.
3. PACK, G. T., and CARVER, L. F. Tumors of the larynx and thyroid; roentgenographic study. *Arch. Otolaryng.*, 1931, 13, 658-675.
4. PANCOAST, H. K. Roentgenology of upper respiratory tract, with especial reference to larynx and adjacent structures. *J. Am. M. Ass.*, 1930, 95, 1318-1321.



MEDULLARY SARCOMA OF VERTEBRA (EWING TYPE TUMOR)

WITH CYSTIC LESION IN RIB

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THIS case is reported because of the curious clinical picture it presented and because of the simultaneous occurrence of two dissimilar tumors of bone in a child.

N. B., male, aged thirteen; occupation, caddy; admitted October 13, 1931, on the service of Dr. Samuel Kleinberg.

The family, previous medical and surgical histories were unimportant.

Present History. Onset one year ago with dull pain in lumbar spine which radiated down left thigh. This pain recurred at irregular intervals without producing any disability. The total period of discomfort lasted but two months. About six months ago, he suddenly experienced great difficulty in walking. His peculiar gait was commented upon by his relatives and friends and has persisted to date. About six weeks ago, on the advice of a physician, he went to bed for a period of about one week, at the end of which time a plaster jacket was applied for the correction of a deformity in the lumbar region. He presents himself wearing a plaster jacket. About one week or ten days ago, he first noted a burning sensation in the right foot, which later radiated to the right thigh. Three days ago he developed a paresis of both lower extremities unaccompanied by either rectal or vesical incontinency. There is no anesthesia of either extremity. A spinal puncture performed two days ago by a private physician was reported negative.

Orthopedic Status. The back is symmetrical. The spine is in the midline. The lumbar curve is somewhat flattened and there is a prominence in the region of the second lumbar vertebra, but no definite knuckle formation. A slight muscle spasm is present. All movements of the spine are restricted. Patient walks awkwardly and with a marked ataxia. There is evidently marked weakness of both lower extremities. He lifts the extended limbs on both sides with the greatest difficulty, but when the knees are flexed he does so more easily. There is no evi-

dence of paralysis, but there is extreme paresis of the muscles. Knee jerks and Achilles tendon reflexes are present.

Laboratory Data. The routine urine examination was negative and Bence-Jones protein was not found. Hematology: Hb, 70 per cent; red blood cells, 3,400,000; white blood cells, 7,000; neutrophils, 61 per cent; eosinophiles, 1 per cent; basophiles, 1 per cent; lymphocytes, 38 per cent; mononuclears, 1 per cent. Blood chemistry revealed Ca 11.5, and P 5. Serology: Wassermann, alcohol antigen, 1+; cholesterol antigen 2+. Complement fixation, negative. Quantitative tuberculin test, negative.

Roentgen Examination on October 20, 1931, revealed the following: Examination of the spine reveals a destructive process involving the body of the 3rd lumbar segment, which extends backward into the posterior arches, as well as into the transverse processes of this vertebra, particularly on the right side. The lesion is osteoclastic, practically no reactive changes being demonstrated. The articular surfaces of this vertebra appear to be intact and the body proper reveals a slight expansion, anteriorly, so that the anteroposterior diameter of this segment is increased. The joint spaces between the 2nd and 3rd, as well as between the 3rd and 4th lumbar vertebrae, appear to be intact. There is a slight collapse of the segment involved. The lateral view of the lumbosacral region reveals irregular erosion or destruction of the posterior surface of the 1st sacral segment, associated with some bone production in the soft tissues overlying this part. Examination of the ribs reveals localized cystic destruction in the 9th rib, right side, beginning about 3 inches from its spinal attachment and extending outward in this rib for a distance of 1 1/2 inches. A moderate expansion of the rib is present. No reactive changes can be demonstrated. Examination of the skull, lungs, dorsal spine, shoulder girdles and pelvis is roentgenographically negative. Conclusion: Malignant tumor, 3rd lumbar vertebra with metastasis

to the 9th rib, right side and probable metastasis to the sacrum (Figs. 1 and 2).

It seemed obvious from the roentgenogram that we were dealing with a neoplasm involving the spine, rib, and possibly the sacrum. As it was impossible to identify the lesion roentgenographically, it was considered advisable to remove a section of the rib for microscopic study. Accordingly, a section was resected subperioste-

flamatory bone tissue. The cyst walls are bony and somewhat irregular, but small amounts of granulation tissue could be removed.

Microscopic: The expanded portions of the ribs show cysts free of tissue. The walls are lined by thin fibrous tissue layer underneath which is newly formed fiber bone. The cysts are trabeculated and in the expanded portion of the rib the marrow adjacent to the cysts contains large

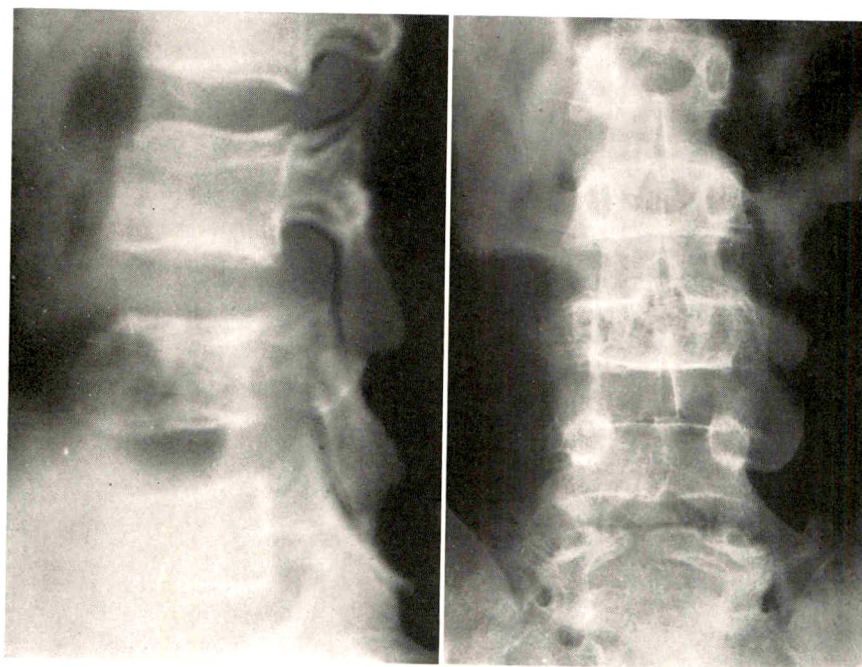


FIG. 1. Destructive lesion in the body of the third lumbar vertebra involving the lateral arches. Note intact intervertebral joints and slight compression of the segment.

ally by Dr. Kreitman. The specimen was examined by Dr. Henry Jaffe who reported as follows:

Gross: Specimen consists of part of a rib measuring 6 cm. in length and about 1.5 cm. in width at its widest point. On making a sagittal section through the entire length of the rib it is found that the rib over a distance of about 1 cm. appears normal. The cortex is of normal thickness and compactness. From this point on the rib shows expansion with conversion of the marrow cavity into a more fibrous and spongy bone. On the ballooned-out area of the rib, multiple cystic spaces measuring as much as 1 cm. in diameter are seen. The cystic spaces are partitioned off by a thin wall of fine bony trabeculae. The cysts contain no fluid or in-

collections of lymphocytes. No lymphoid follicles are seen. Within the collections of lymphocytes, some polymorphonuclear leucocytes are also observed. The cortex adjacent to and in the vicinity of the cysts shows some enlargement of the vessel canals and some evidences of transformation with an irregular architecture. *Diagnosis:* Simple multilocular cysts of the rib (Figs. 3 and 4).

On the fourth day after operation, the patient developed a profuse watery diarrhea which persisted for three days. Blood examination at this time revealed a moderate leucocytosis. A diagnosis of acute enteritis was made and after proper medication, this acute situation rapidly subsided. On November 9, 1931, he was placed on a convex frame. Examination

one week later revealed a hard mass in the abdomen at the level of the spinal lesion. This mass was somewhat globular, about the size of a walnut and non-sensitive.

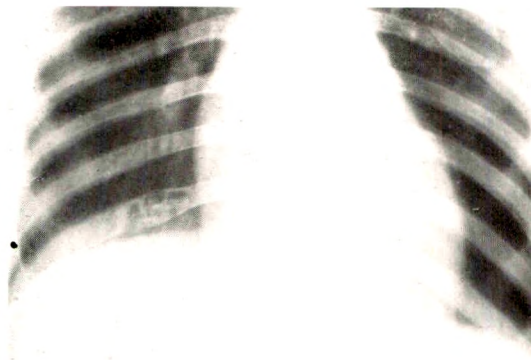


FIG. 2. Cystic trabeculated and expansile lesion in ninth rib right side.

The situation at this time (Nov. 23, 1931) was as follows: The tumor of the rib had been proved a benign cyst of bone and the assumption was that the lesion of the vertebra was of identical nature. The patient's general condition was good, the fever had subsided, but the paresis was progressing and the pain becoming more intense. There appeared to be every clinical indication for surgical interference and it was thought that further collapse of the vertebral column could be prevented by a decompression and fusion operation. At the same time, a specimen of the tumor could be removed to further establish the nature of the neoplasm. Accordingly, the patient was operated upon and Dr. Kreitman's notes are as follows: A 6 in. midline incision was made over the spinous processes of the 12th dorsal to the 5th lumbar vertebrae. The spinous processes and laminae on the left side were exposed subperiosteally. As the intervertebral joint between the 2nd and 3rd lumbar segments was exposed, it was found that there was granulation tissue between the two laminae. The laminae and spinous processes were then exposed; on the right side, this same granulation tissue was found in the same relationship as on the left side. The laminae of the 2nd and 3rd lumbar vertebrae were found to be mottled and appeared to be somewhat softer than those of the other vertebrae. The spinous processes of the 1st, 2nd, and 3rd lumbar verte-

brae were removed and the laminae on the right side of these same vertebrae were opened. It was found that when the spinal column was first opened at the level of the 3rd lumbar vertebra the cord did not pulsate, but as the column was opened above, the cord began to pulsate. The extradural anterior portion of the canal was inspected and nothing of note was found. The dura was opened and a probe inserted above and below to make sure that there was no block farther above or below this point. The superior articular facet on the right side of the 4th lumbar vertebra was found to be soft and irregular. This was easily removed and with the finger it was explored laterally. As the finger was inserted laterally, there was a gush of a hemorrhagic, whitish, gelatinous fluid. With a curette, some of the bone in this area was removed. The bone chips that had been removed in performing the laminectomy on the right side were inserted over the laminae of the left side to bring about the spine fusion.

The specimens were referred to the laboratory for section and culture. The culture was reported sterile. The report of the section submitted to the laboratory was as follows:

Gross: Specimen consists of tissue removed from the spinous process and the laminae on the right side especially, and from a cystic structure that was opened into in one of the

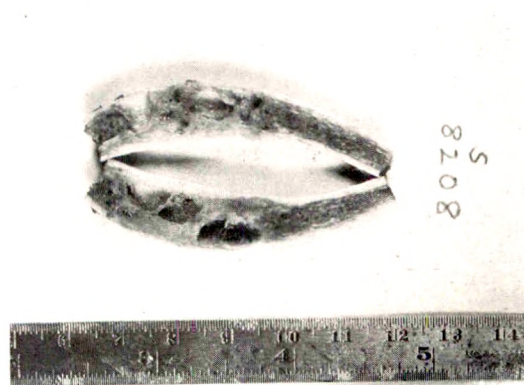


FIG. 3. Photograph of the gross specimen, natural size, showing part of the normal rib and also the expanded rib with cysts.

bodies of the lumbar vertebra after the cord was pushed to the left. The soft tissues from the cystic cavity showed on smears, an absence of bacteria, and in the Wright and Gram stains the cells were very large and contained nuclei

that apparently occupied the whole cell. Some of this soft tissue was almost of the consistency of pus and this was cultured. The rest was marked No. 1. The soft tissue and spongy bone removed from the cavity were marked No. 2, and decalcified in nitric acid. The tissue from the lumbar and spinous processes which in the gross showed nothing was marked No. 3 and was also decalcified in nitric acid. *Microscopic:* Sections from the tissue marked No. 1 show numerous small vessels that are thickened. Between these vascular spaces there are collections of deep-staining blue cells but also others in which the cells do not stain well. Sections from the tissue marked No. 2 show similar collections of dark-staining cells subchondrally with marked areas of resorption of the bone and intertrabecular scarring. Other sections show a very vascular and edematous marrow with marked resorption of the bony trabeculae. In this vascular, edematous marrow there are clumps of large blue-staining cells. The marrow shows some fibrous reaction with scarring. In the sections marked No. 3 some of the intertrabecular spaces contain masses of cells, the cell borders of which are not very distinct. These cells have large nuclei that fill practically the entire cell. They are fairly compact and they become continuous with the adjacent fibrotic marrow. Other sections show fairly

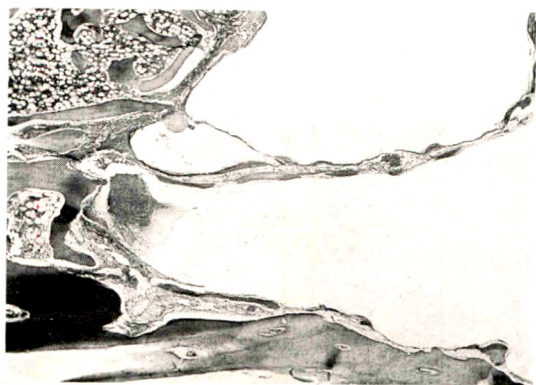


FIG. 4. Photomicrograph of part of this rib showing the cortex and two cysts partitioned by a thin septum which is made up of fine trabeculae of bone. The bone marrow except where it is immediately adjacent to the cyst appears normal in all respects ($\times 15$).

diffuse tumor, but in other areas scarring is observed with clumps of leucocytes, in fact in some places resembling miliary abscesses. *Diag-*

nosis: Medullary sarcoma (so-called Ewing's tumor) (Fig. 5).

Re-examination, both gross and microscopic,

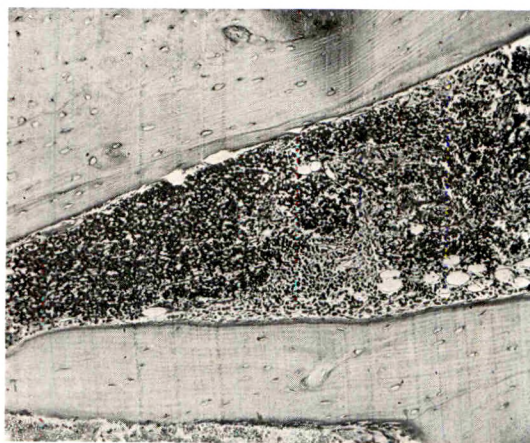


FIG. 5. Shows some of the tumor between two trabeculae of bone from spine. The tumor cells are quite compact, blue-staining. The entire mass is rather solid ($\times 100$).

of the rib specimen failed to reveal any evidence of a lesion suggestive of sarcoma. While speculation is possible no evidence exists for believing that the rib also had a sarcomatous focus which had undergone spontaneous resolution with the resultant cystic transformation which was observed on roentgen examination and is shown in Figure 3.

Following the operation, there was a moderate rise in temperature, without, however, any discomfort. Patient stated that the right lower extremity had somewhat improved. However, his appetite failed and his anemia became pronounced. A transfusion of 500 c.c. of blood was done on December 4, 1931. I quote from the clinical notes by Dr. Kleinberg. "On December 4, he had a transfusion of 500 c.c. of blood. Since that time, temperature has receded to normal; the pulse is now normal. He looks very much better and feels better. Patient states that numbness in the right lower limb is gradually disappearing. The knee jerks are not present. The ankle jerks are absent. There is no power in the right lower limb except for a little power in dorsiflexion of the foot and toes. He has also slight power in the sartorius and flexors of the knee. Left lower limb: He is able to flex it at the hip and knee. There is some power of extension in the quadriceps. There is very slight power of dorsiflexion of the foot. The wound of

the spinal operation is healing satisfactorily."

In view of the report from the pathological department, it was decided to treat the affected areas by means of a radium pack, and the treatment was administered in the following manner: On December 19, 1931, a 335 mg. pack was applied to the lumbar region posteriorly over the tumor. A total irradiation of 8,040 mg-hr. was administered over a field 8×10 cm. at a focal skin distance of 6 cm. and filtered through 2 mm. of lead. On December 20, the same pack was administered anteriorly at the level of the lesion using the same factors and giving a total radiation of 6,365 mg-hr. On December 31, the lumbar area posteriorly was irradiated using the same factors for a total of 8,040 mg-hr.

On December 31, 1931, the abdominal masses were no longer palpable and there was a marked reduction of pain. Mobility of the spine had increased and the function of the left leg improved. The right lower extremity was unaffected. Four days later, motion in the left lower extremity was freer and there was some return in the power in the right lower extremity. His improvement was fairly rapid and the patient was accordingly discharged on January 6, 1932, and advised to return for further observation and, if necessary, irradiation.

DISCUSSION

In the roentgen diagnosis, the following conditions were considered: tuberculous caries with concomitant involvement of a rib; vertebral osteochondritis; fibrocystic disease and malignant tumor with metastasis to the rib.

Tuberculous caries was excluded because there was no involvement of the inter-

vertebral joints and insufficient collapse of the vertebral segment considering the extent of the destructive process. The destruction appeared to involve the body proper rather than its articular surfaces. There was no paravertebral soft tissue thickening. The involvement in the rib was expansile in character rather than destructive, as one would expect in tuberculosis.

Vertebral osteochondritis results in compression of the involved segment associated with condensation of the cancellous structure, so that the body appears denser than normal. In the case cited the vertebra showed patchy necrosis. Considering the extent of the destructive lesion in the involved segment, there was no very striking compression of the body. We would still have to explain the nature of the lesion in the rib.

Fibrocystic disease. The lesion in the rib was expansile in character, cystic in appearance and showed slightly eburnated edges. The diagnosis of cystic bone disease would have been justified but would not have explained the nature of the lesion in the vertebra. The lesion in the vertebra was "moth-eaten" in character, not expansile and showed no trabeculations.

While the two lesions were dissimilar roentgenologically, it appeared more logical to assume that they were both unusual manifestations of one disease. The diagnosis of a malignant tumor of the vertebra with metastasis to the rib was therefore made by exclusion.



THE INCIDENCE OF MALIGNANCY IN CHRONIC PREPYLORIC GASTRIC ULCERATIONS*

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THE purpose of this communication is to emphasize a relatively new factor in the differential diagnosis of chronic prepyloric gastric ulcerations. This factor pertains to the anatomical location of the lesion. Observations are reported which seem to indicate that chronic prepyloric gastric ulcerations should be considered and treated as malignant ulcers. The facts obtained from a study of the records of the Massachusetts General Hospital over a period of ten years and the results of three years of practical application of these findings are presented. No attempt will be made to evaluate other well-recognized diagnostic criteria; indeed, these criteria are intentionally omitted.

The utilization of the site of a lesion as an aid in the diagnosis of disease is a well-recognized procedure and is used in many departments of medical diagnosis. It is well recognized in dermatology that certain diseases of the skin involve usually the flexor surfaces of the extremities while others involve most frequently the extensor surfaces. In pulmonary disease, it is a well-known and generally accepted dictum that all lesions above the third ribs in front are to be considered tuberculous until proved otherwise and that all lesions below the third ribs in front should be considered non-tuberculous until proved otherwise. The occasional occurrence of a non-tuberculous lesion above the third rib and the comparatively rare finding of a tuberculous lesion below the third rib in front does not invalidate but rather serves to strengthen the dictum.

An example of the utilization of the location of a lesion as an aid in the diagnosis of gastric disease was presented before this Society by Sproull⁶ in his discussion of the occurrence of benign ulcers on the greater

curvature of the stomach. His conclusions were that any lesion situated on the greater curvature of the stomach would be safely diagnosed as neoplastic on the basis of location without regard to or consideration of other diagnostic factors. We have found that this method, namely, localization, may be used to determine the nature of prepyloric ulcerations. It is well known that the benign or malignant nature of some gastric ulcerations cannot be determined by gross examination.

The exact location of benign chronic gastric ulcerations has not received sufficient attention if one is to judge from the statements made in the many medical textbooks and periodicals. Many authorities believe that these ulcers occur most commonly in the lower third of the stomach. The "gastric pathway" and "the ulcer-bearing area of the stomach" are unconvincingly discussed. However, a few pathologists and roentgenologists have studied this subject carefully and have attempted to localize the areas within the stomach in which benign ulcer or carcinoma are more likely to be found.

In 1925, Orator,⁵ working with material obtained from the Eiselberg Clinic, attempted to correlate the sites of occurrence of chronic gastric ulcerations with their tendency to undergo malignant degeneration. He also discussed the relation of diffuse and localized chronic gastritis to the malignant degeneration of gastric ulcers. His work is of great value both for the completeness of his study and the accuracy of his observations. He is quoted by Haudek,³ Camp,¹ and others. His material consisted of 330 stomach specimens showing ulcerations which were studied grossly as to location; and histological studies were also done to determine the presence of

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

malignant degeneration. A part of his work is tabulated by us in Table I.

It is not the purpose of this presentation to decide whether or not benign gastric

benign ulcers in the prepyloric area in 6 per cent or less of the total cases studied.

Haudek, reviewing his experience of many years in the roentgen diagnosis of gastric lesions, recognized the difficulties experienced in distinguishing between benign and malignant lesions in the prepyloric region. He states:

"The prepyloric segment is the most frequent site of carcinoma—about 80 per cent of carcinomata start here. Ulcers are certainly least commonly found here—occurring in about the proportion of 1 to 10 as compared with ulcers of the pars media. But the relatively small number of ulcers which occur in this region have three peculiarities which complicate the differential diagnosis: (1) They show 'niches' less frequently than in other situations. (2) These ulcers are associated with more marked submucous oedema, with an increased tendency to spasm of the gastric musculature, and a more considerable degree of mucous membrane swelling. As a result the lumen of the pyloric part of the stomach is quite often narrowed, giving appearances similar to carcinoma." A case is here quoted. He continues: "My own experience agrees with the facts established by Orator on material from the Eiselsberg Clinic that about one-third of prepyloric ulcers undergo cancerous degeneration, but only 3 per cent of ulcers of the pars media, and hardly ever a duodenal ulcer. *The difficult differential diagnosis*

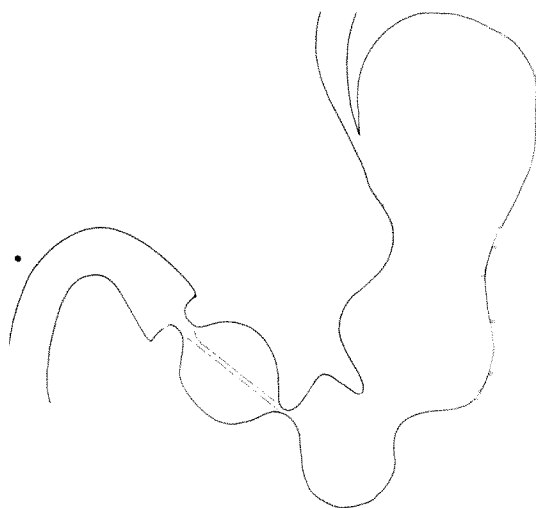


FIG. 1. The distal egg-shaped portion of this diagrammatic sketch of the stomach represents the prepyloric area as defined. The pyloric valve is not included in the prepyloric area. The dotted lines represent the lumen of the stomach as the peristaltic waves "canalize" it. The length of the lesser curvature side of the prepyloric area is taken to be one inch.

ulcers become malignant. Particular attention is directed to the percentage of prepyloric ulcerations which Orator interprets as having undergone malignant changes. If we have translated his statements correctly, he has classed the group of 15 questionable ulcerations chiefly within the prepyloric area. He definitely states that the 11 prepyloric ulcerations which had apparently degenerated into malignancy would be increased in number if he had included the questionable group. It is apparent, therefore, that Orator found

TABLE I
GASTRIC ULCERATIONS (ORATOR)

Media lesser curvature.....	300	
Prepyloric.....	30	
Malignant Degeneration		
Media lesser curvature.....	6	per cent 2
Prepyloric.....	11	30
Questionable.....	15	30+

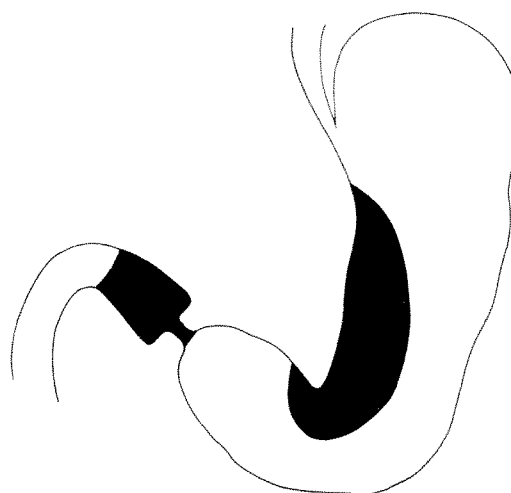


FIG. 2. The shaded portions of this diagram illustrate the usual site of occurrence of chronic benign ulcers. Note that the prepyloric area, greater curvature, and cardiac end are left blank.

and the tendency to malignant degeneration are sound reasons for recommending operation in prepyloric ulcer." (The italics are ours.)

Lehmann⁴ examined the stomach and duodenum in a series of 1000 necropsies for signs of active or healed ulcers. He based his findings on both the gross and histological evidence. Ulcers or the scars of ulcers were found in 202 cases; in the stomach the relation of scars to active ulcers was as 9 to 1, the number of active ulcers increasing as the pylorus was approached. By far the greater number of scars were located toward the cardiac end of the stomach. He did not state definitely the number of ulcers or scars in the prepyloric area; instead, he used such terms as "near the pylorus" and "away from the pylorus." It is interesting to note that one of his illustrative sketches contains markers indicating that only two healed ulcers were in the prepyloric area.

Camp, in a summary of the facts concerning prepyloric ulcer obtained from the literature and from the material at the Mayo Clinic, states that it is apparent that the roentgenologic simulants of the lesion are numerous and far more common than prepyloric ulcer itself. He advised withholding a diagnosis unless an ulcer niche can be demonstrated without question.

Stone and Ruggles⁷ have noted the frequency with which prepyloric lesions are found to be malignant. They report one case of proved benign prepyloric ulcer.

Dresser² quotes Lehmann and refers to the frequency with which benign ulcer occurs on the lesser curvature of the stomach.

We deem it necessary at this point to define the term "chronic prepyloric ulcerations" as used in our study of the subject. It is desired that "chronic" be not ignored but interpreted literally and perhaps it would be better if "indurated" were added. The prepyloric area is here sharply limited to that portion of the stomach just proximal to the pyloric valve which is one inch in length. No part of the pyloric valve is

included in the prepyloric area. Aside from actual measurement, this portion of the stomach may be identified during roentgenoscopy by its canalization at the height of peristaltic activity. In some of the lower animals this portion of the stomach is grossly demarcated; for example, an abrupt change in both the gross and histological

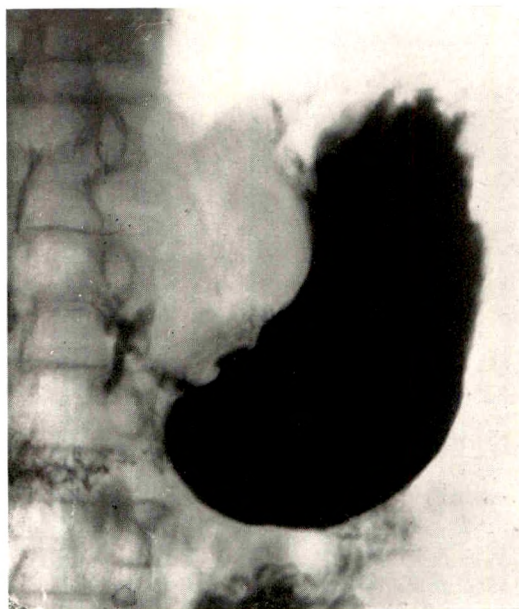


FIG. 3. The roentgen diagnosis was duodenal and gastric ulcer. The position of the gastric ulcer niche was recorded by the roentgenologist as being "at the upper margin of the deformed prepyloric area," but the pathologist placed the lesion within one inch of the pyloric valve.

structure is noted in the rat's stomach just above the pylorus. Often, in the freshly removed human stomach, a definite transition is noted in the mucosa at the beginning of this prepyloric area. In view of the fact that it is seldom possible to study the mucosa of the stomach as it exists in the living, one may perhaps justly doubt the existence of accurate knowledge of the mucosa of the living human stomach. Certainly, the prepyloric area presents definite differences in physiological activity and response to disease when compared with the remainder of the stomach, and it is this inherent peculiarity which limits nearly

all diagnostic procedures directed to it (Figs. 1 and 2).

To determine as nearly as possible the exact locations of chronic gastric ulcers, it was considered best to select those records which contained roentgen, surgical, and pathological reports. Even though a period of ten years was covered, only a relatively

sider to be the greatest sources of error.

With the above governing factors and the roentgen, surgical, and pathological reports taken into account, the following tabulation was prepared (Table II):

TABLE II
LOCATION OF ULCER OF STOMACH (ROENTGEN, SURGICAL AND PATHOLOGIC)

	Number	Per Cent
Location (?)	9	7.0
Pylorus	28	21.9
Near pylorus	6	4.7
Prepyloric	2	1.6
Media	83	64.8
Total	128	100

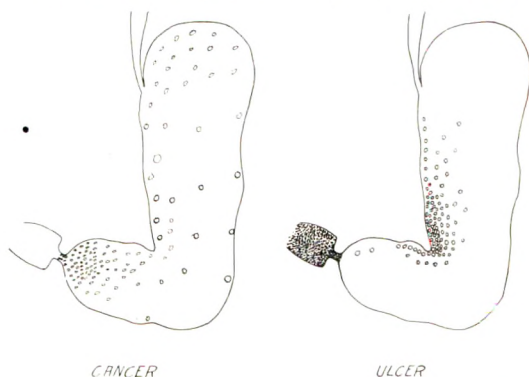


FIG. 4. In the diagram marked "ulcer," the site of the 128 proved benign gastric ulcers is indicated. In the opposite diagram, marked "cancer," the position of 121 carcinomata as localized and diagnosed by the roentgen examination alone is illustrated. Particular attention should be paid to the fact that most of the benign ulcers were placed in the middle third along the lesser curvature and posterior wall, whereas most of the carcinomata were found in the distal end of the stomach. The proportion of carcinomata as diagnosed by roentgen examination alone to proved prepyloric ulcers is considerably above the 12 to 1 ratio already stated.

small number of complete records were obtained due to the fact that most gastric ulcers are treated medically at the Massachusetts General Hospital. To locate the ulcers accurately, the center of each ulcer was taken as its site of origin; for example, an ulcer 6 cm. in diameter occupying the prepyloric area was localized at a point 3 cm. above the pyloric valve and was not classified as a prepyloric ulcer. All ulcers extending well into the pyloric valve were considered to be pyloric valve or duodenal ulcers since the anatomical landmarks were usually obscured. There is no doubt that some of the ulcers reported in the pyloric valve originated in the duodenum or elsewhere in the stomach and these we con-

Nine of the ulcers could not be definitely localized due to destruction of the anatomical landmarks. The pyloric valve was thought to be the seat of ulcer in 28 instances. The most definite statement made in the record either by the surgeon, roentgenologist, or pathologist, was "near the pylorus" in 6 cases. In many records the term "near the pylorus" proved to be entirely misleading, for ulcers so localized by one examiner proved to be variously located from the middle third of the stomach to the duodenum by the other two examiners. It is surprising that only 2, or 1.6 per cent, of the ulcers were found to be definitely

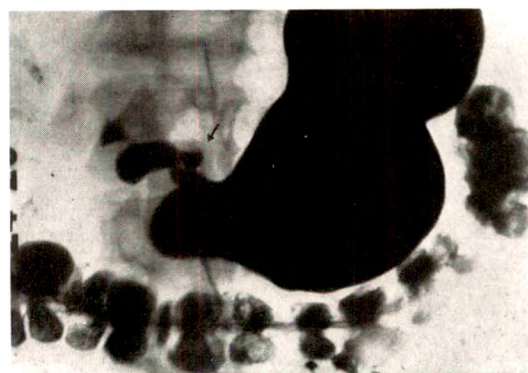


FIG. 5. Pathological report—ulceration 1.5 cm. in diameter which on histological examination showed adenocarcinoma with metastases to regional lymph nodes.

within the prepyloric area. As the above tabulation was prepared before any of the literature was reviewed, it is interesting to compare our findings with those of Orator. If we add the "near pylorus" and "prepyloric" percentages in our table, the sum (6.3 per cent) corresponds closely with the percentage of benign prepyloric ulcers found by Orator (6 per cent). It is probable that he included more than the distal one inch of the stomach in the prepyloric area. Our records show that neither of the two prepyloric ulcers tabulated above could be so localized by the roentgen examination alone. Indeed, the roentgen diagnosis of chronic benign prepyloric gastric ulcer as defined by us was not confirmed by pathological examination in a single instance (Fig. 3).

It was thought advisable to establish the relative proportion of carcinoma and ulcer occurring in various portions of the stomach, and to do this it was found necessary to rely on the roentgen diagnosis alone since not enough complete gastrectomies were performed. The tabulation below is



FIG. 6. Pathological report—superficial ulcer 2 cm. from pylorus, 1 cm. in diameter, also small shallow ulcer 1.5×1.2 cm. in pyloric ring. Both ulcers show histological appearance indicating slowly growing scirrhus carcinoma.

composed of material obtained from the Roentgen Department in the years 1928 and 1929. Several of the patients diagnosed as having ulcers were re-entries but nearly all of the patients thought to have car-

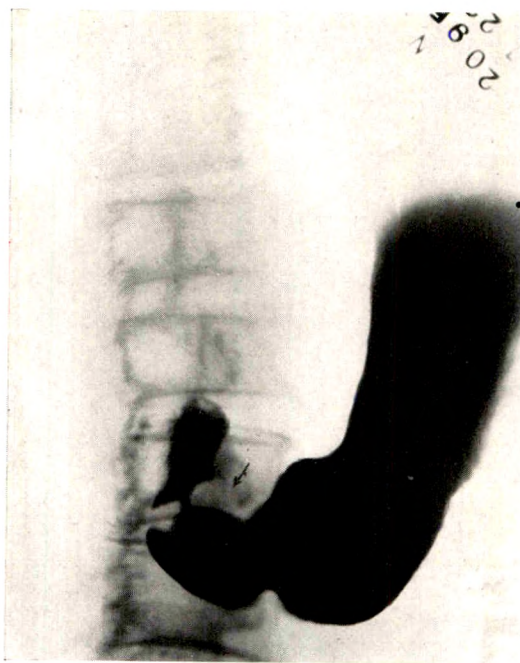


FIG. 7. Pathological report—3 cm. ulcer in contact with the pyloric valve which on histological examination showed adenocarcinoma.

cinomata were examined only once (Table III).

The importance of comparing the location of benign and malignant lesions of the stomach is apparent. In practically an equal number of roentgen examinations of

TABLE III
LOCATION OF ULCER AND CARCINOMA; ROENTGEN DIAGNOSIS (1928 AND 1929)*

	Ulcer	Carcinoma
Pyloric end (pylorus)	39	75
(prepyloric)	6	
Media	80	17
Cardia	3(?)	21
Diffuse	0	8
Total	128	121

* Relative proportion of prepyloric ulcer to carcinoma approximately 1 to 12.

the stomach, it was thought that there were 6 ulcers and 75 carcinomata involving the prepyloric area. Thus the relative proportion of benign prepyloric ulcers to carcinomata in this same area of the stomach is as 1 to 12, i.e., in a given case where definite pathology is localized to the prepyloric area the chances of the lesion being carcinoma are twelve times as great as are the probabilities of its being a benign ulcer. Of course, when one considers the sources of error in the roentgen diagnosis of prepyloric ulcer, the 12 to 1 ratio becomes much greater (Fig. 4).

In view of the above findings, it was thought advisable to follow up those patients who had had only posterior gastro-

enterostomies without any other operative procedure for the treatment of what was thought to be benign chronic prepyloric ulcerations. It was possible to obtain fairly complete records of 8 such patients. All of these patients returned to the hospital within an average period of two years, presenting unmistakable evidence of advanced carcinoma of the stomach (Table IV).

During the last three years, it has been possible to test the accuracy of the statistical data and theoretical considerations above presented. Although we had the co-operation of the surgeons, pathologists, and roentgenologists of the Massachusetts General Hospital, not a single instance of chronic benign prepyloric ulcer, as we have

TABLE IV
THE ROENTGEN, OPERATIVE AND FOLLOW-UP DIAGNOSIS IN EIGHT SELECTED CASES OF PREPYLORIC ULCER

Hospital Number	Roentgen Findings	Operative Findings	Final Diagnosis
283365	Gastric ulcer at the prepylorus (?); malignancy	Gastric ulcer on the lesser curvature 3 cm. above the pylorus (1927)	Tumor involving the pyloric end (1929), adenocarcinoma, removed; operative and pathologic diagnosis
273408	Obstruction at the outlet; probably malignant	Ulcer on the gastric side of pylorus (1925)	Operative findings, 1929: carcinoma, inoperable
272829	Obstruction at the outlet of the stomach	Thickening exactly at pylorus with ulcer above it (1925)	Roentgen and clinical findings, obvious carcinoma; patient died in January, 1927
262864	Obstruction at the pylorus	Lesion on the lesser curvature which ended abruptly at the pylorus; old callus ulcer (1924)	No operation; definite carcinoma; roentgen and clinical findings
481562	Obstruction at the pylorus, probably ulcer	Indurated lesion near the pylorus (1922)	Carcinoma lower third, 1923; adenocarcinoma; operative and pathologic findings
461562	Ulcer near the pylorus	Benign ulcer (1926)	Mass head of pancreas and large ulcer just above pylorus; malignant condition seemed certain (1927); operation
253091	Obstruction at the pylorus, probably ulcer	Ulcer above the pylorus (1921)	Enlarged liver, jaundice; roentgen diagnosis: carcinoma of the stomach (1922)
250411	None	Gastric ulcer (1920)	Palpable mass, obvious carcinoma (1922)

defined it, has been discovered.* In contrast with this, 13 malignant prepyloric ulcerations were resected which were 3 cm. or less in diameter. A large percentage of these ulcerations were thought to be benign by the surgeons and pathologists from a study of their gross pathology. Examination by routine frozen sections was not found dependable for accurate diagnosis nor was it possible to arrive at a correct histologic diagnosis by the study of a single paraffin section. It was found necessary and it has become our custom to require several paraffin sections from various portions of these prepyloric ulcerations before the histological diagnosis is accepted (Figs. 5, 6, 7 and 8).

* Since this paper was read, 2 benign prepyloric ulcers and 5 prepyloric malignant ulcerations (3 cm. and less in diameter) have been discovered. One of the patients presenting a benign prepyloric ulcer had a positive Wassermann and the ulcer was on or very near the greater curvature.



FIG. 8. Pathological report—ulcerating lesion 2.3 cm. in diameter extending into pylorus. Lesion is slightly firm and margins raised about 4 mm. Microscopic diagnosis—adenocarcinoma with metastases to regional lymph nodes.

REFERENCES

1. CAMP, J. D. The roentgenologic significance of pyloric and prepyloric deformities. *Radiology*, 1931, 16, 847-855.
2. DRESSER, R. The roentgen examination for peptic ulcer, with special reference to those cases presenting unusual difficulties in diagnosis. *N. England J. M.*, 1931, 205, 395-399.
3. HAUDEK, M. X-Rays in diagnosis of early carcinoma of the stomach. *Brit. J. Radiol.*, 1929, 2, 421-433.
4. LEHMANN, H. Ein Beitrag zur Frage der Frequenz und Lokalisation des Ulcus pepticum, ventriculi et duodeni. *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1926, 39, 185-204.
5. ORATOR, V. Beiträge zur Magenpathologie. II. Zur Pathologie und Genese des Carcinoms und Ulcuscarcinoms des Magens. *Virchow's Arch. f. path. Anat.*, 1925, 256, 202-229.
6. SPROULL, J. A discussion of the occurrence of benign ulcer on the greater curvature. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1931, 25, 464-473.
7. STONE, R. S., and RUGGLES, H. E. The diagnostic value of prepyloric and pyloric roentgen findings. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 27, 193-204.



FURTHER ROENTGEN-RAY STUDIES ON CARCINOMA OF THE STOMACH*

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IN A previous communication presented before the Radiological Society of North America in 1929,¹ I demonstrated the possibility of recognizing early gastric lesions by means of the roentgen ray and called attention to the importance of the indirect or secondary roentgen signs obtained in gastric disease. When gastric lesions are visualized, especially the ulcerative or carcinomatous types, the roentgen examination usually reveals a characteristic filling defect. On the other hand, when a filling defect cannot be demonstrated the diagnosis becomes more difficult and uncertain. This is especially true in that type of case representing the early stages of the disease in which there is but slight induration in the gastric wall. It is impossible at this stage to visualize the ulcer crater or the small early neoplasm. Inasmuch as nearly all early lesions of the stomach present only an infiltration or induration, any sign that will point to these changes before the filling defect has become fully developed is most important. An attempt will be made to demonstrate that this can be accomplished in many instances. The importance of the indirect or secondary roentgen signs in the diagnosis has hardly been sufficiently emphasized and moreover too little attention has been directed to these findings as a possible means of establishing an early diagnosis at that period, before a filling defect can be detected. It is to these signs that we desire to direct attention. The gastric lesions in which the characteristic filling defects are noted are therefore not considered in this discussion.

Reference to the literature on this subject reveals but few communications regarding the early roentgen signs of organic disease of the stomach. While mention is unquestionably called to the indirect signs, but slight significance has been attached to these findings. Positive indirect roentgen signs very frequently occur in many instances before the gastric defect is observed. These secondary signs, when constant, must be considered abnormal and strongly suggest the presence of a gastric lesion. They are repeatedly overlooked by the roentgenologist and their significance is often not fully recognized until later, when subsequent investigation discloses a definite lesion. It is then not unusual to observe that when the films are again compared, the site of the lesion on the films in the earlier examination is readily detected. The importance of frequent roentgen examinations in all instances in which clinical evidence of gastric disease is revealed must be repeatedly emphasized, especially when positive roentgen signs are absent.

My attention has been directed to this study by the observation of a group of cases presenting definite clinical and laboratory findings indicative of gastric disease, without, however, presenting a characteristic filling defect in the roentgen examination. In reviewing a large series of such cases I was especially impressed with the fact that a marked discrepancy existed between the clinical and roentgen findings. From a personal experience with the roentgenological changes observed in this group of cases, I am convinced that it is quite possible in many instances to distinguish these early indirect findings which have heretofore often passed unnoticed. The early recognition of these changes is

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¹ Feldman, M. Early recognition of gastric ulcer and carcinoma as revealed by roentgen-ray studies. *Radiology*, 1932; 15, 449-459.

highly important in view of the fact that they may present the first intimation as to the true nature of the disease.

The material selected for this study comprises a group of 9 cases of carcinoma of the stomach, which are presented to point out the importance which must be attached to the indirect roentgen signs in the diagnosis of this condition. It is therefore the purpose of this communication to discuss briefly this group of cases which presented roentgen changes other than the characteristic projecting or displacing defects commonly observed in carcinoma. The diagnosis of carcinoma of the stomach was definitely established in each instance.

The roentgenological appearance of the configuration of the stomach presents a picture which varies greatly, depending upon the extent of the lesion. These changes may at times be so slight that it is difficult to detect a departure from the normal. On the other hand, the entire stomach may be involved producing roentgen changes which disclose the presence of an extensive lesion. In this study it was determined, in order to accurately appraise the value of the roentgen signs and properly classify each case, to divide them into two groups. First, the ulcer group and, secondly, the carcinomatous group. Some of our cases could not be classified into

TABLE I. Case I. Table illustrating the detailed blood examinations.
(From the records of the Johns Hopkins Hospital.)

Date	Red Blood Corpuscles	Hemoglobin	White Blood Corpuscles	Differential count								Color Index	Remarks
				Polymorphonuclear Neutrophils	Polymorphonuclear Eosinophiles	Polymorphonuclear Basophiles	Small Lymphocytes	Large Lymphocytes	Monocytes	Unclassified	Myeloblasts		
		per cent		per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	
Nov. before entering Hospital	2,500,000	55	5,000	4			33	43					
Nov. 29 Entered Hospital	2,100,000	50	8,900								98	1.4	
Nov. 29 Repeated				2	0	0	2	3	2	0	91		Blood clots rapidly. Red cells stain slightly. No large red cells; few small ones. Moderate anisocytosis, poikilocytosis.
Nov. 30	1,860,000	53	9,500	3	0	0	1	3	2	0	91	1+	Majority of leucocytes contained many large black staining granules. Bleeding time 3.5 min. Clotting time 2 min. Blood culture negative.
Dec. 1	2,780,000	55	5,400									1+	
Dec. 14	1,750,000	52	1,260	2								1.5	Platelet count 40,000 cells; highly colored R.B.C. No noticeable anisocytosis or poikilocytosis.
Dec. 5	1,900,000	55										1.4	
Dec. 7	2,240,000		1,800	25	0	0			0	15	60	1.2	Platelet count 50,000

either group and had to be placed in an undetermined class. The majority, however, could be definitely placed in either the ulcer or cancer classification.

serial roentgenograms is essential for the determination of early roentgen gastric changes. These present the only means of pointing out the slight changes in the

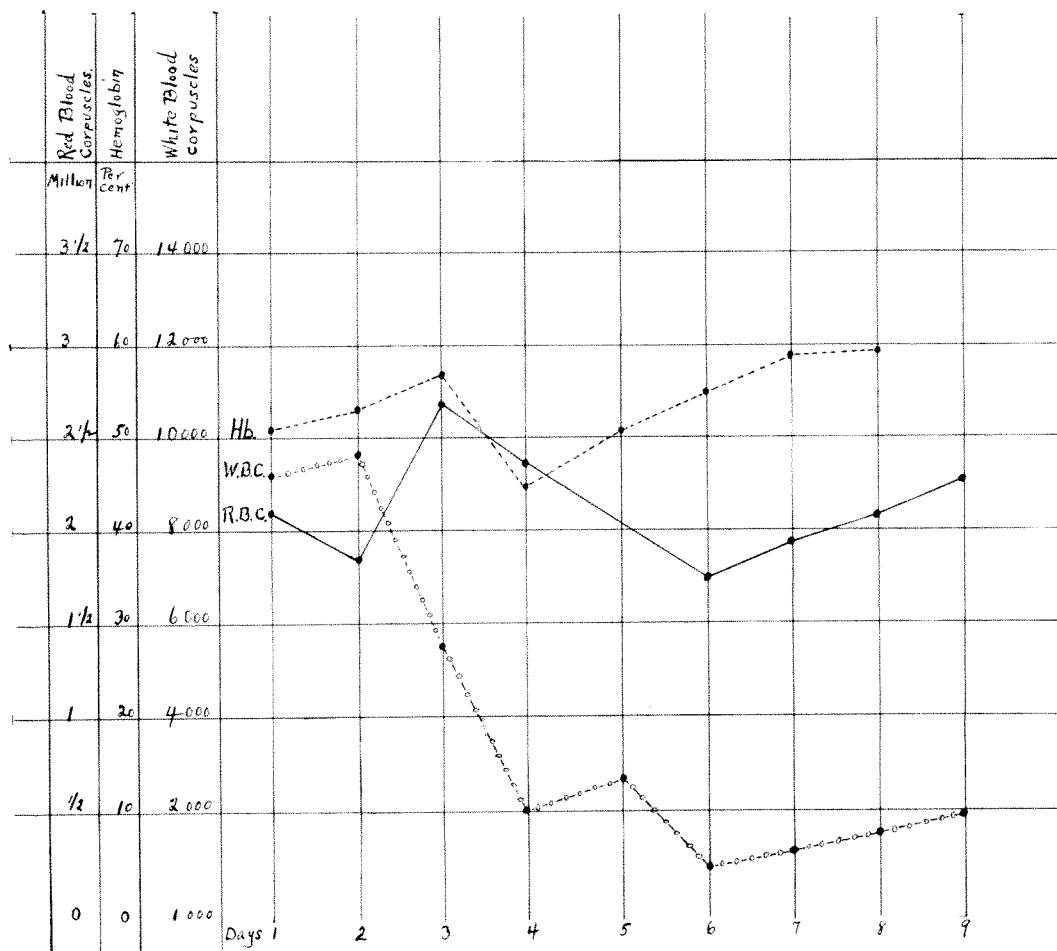


CHART I. Case I. Illustrates the relation of the red blood corpuscles, white blood corpuscles and hemoglobin. (From the records of the Johns Hopkins Hospital.)

In the routine gastrointestinal roentgen study of the stomach a thorough roentgenoscopic examination is required. It is of interest to note that in this examination the change in the gastric configuration at times may not become apparent to the observer and no intimation as to the true nature of the pathologic condition is presented. The roentgenoscopic examination reveals in most instances a normal picture of the stomach. This examination alone, however, should not be relied upon without the usual series of films. A group of

contour of the curvatures of the stomach. In order to establish with some certainty the diagnosis of a gastric lesion, these changes must be constant.

The most striking features of the indirect roentgen findings are the disturbance in the peristalsis, alteration in the shape and size, and rapid emptying of the stomach. The presence of some alteration in peristalsis, producing disorganization in the regular passage of the waves is probably the earliest possible change encountered in gastric disease involving the wall of the

stomach. As the condition progresses, the size of the stomach gradually becomes smaller and apparently shorter. These changes are best illustrated by means of serial roentgenography. Tracings of the stomach may be made, superimposing one film upon another in order to indicate graphically the variations in the peristaltic waves. In carcinoma it will be noted that the alteration in the peristaltic movements is so marked as to involve a considerable portion of the stomach. In the later stages the entire stomach may become affected

time is markedly accelerated. The sphincteric equilibrium of the pylorus is also usually involved exhibiting a distinct pa-

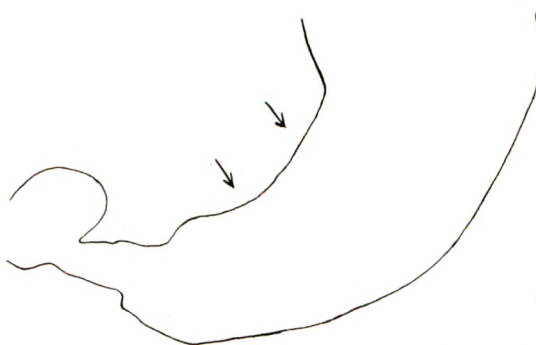


FIG. 2. Case 1. A tracing from one of the roentgenograms.

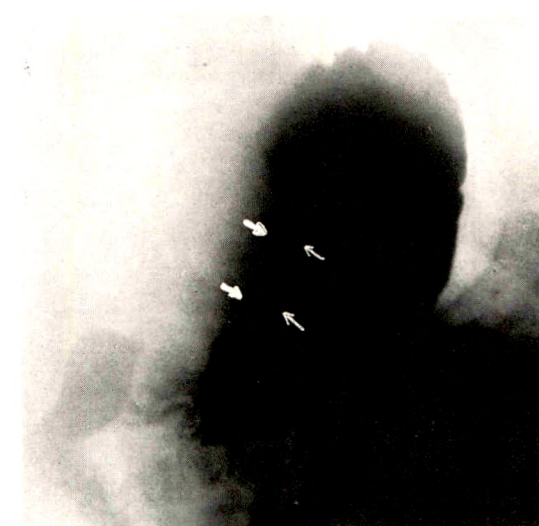


FIG. 1. Case 1. Roentgenogram showing an extremely small stomach, with a fixed area on the lesser curvature.

without, however, revealing the typical irregular displacing filling defect characteristic of this condition.

The early changes are principally due to the infiltration and induration, in addition to the surrounding associated inflammatory reaction.

The stomach becomes fixed in appearance, presents a stereotyped form, usually involves both curvatures, though in a few instances only a small fixed area may be observed. When both curvatures are affected, the stomach appears greatly shortened, is small in size and is situated high under the left diaphragm. The emptying

tency. At this period there may not be any break in the regularity of the contour of the curvatures and no classical filling defect characteristic of carcinoma can be demonstrated. A palpable mass cannot be detected at this age. As the condition progresses, however, after a varying period of time, a further roentgen investigation may reveal a filling defect. When the cardia of the stomach is involved, esophageal invasion usually ensues. This had occurred in several instances in the late stage of our cases.

The changes in peristalsis, motility, contour, size and shape of the stomach do not, however, indicate the presence of



FIG. 3. Case 1. Tracings from a series of roentgenograms superimposed, illustrating a persistent fixed area on the lesser curvature.

carcinoma in all instances. These findings, moreover, point to a definite gastric lesion, the true nature of which cannot always be definitely determined. The foregoing gastric changes are all well recognized findings and no attempt is here made to indicate that they be regarded as new, but they are merely emphasized as important early changes which may lead to an early diagnosis.

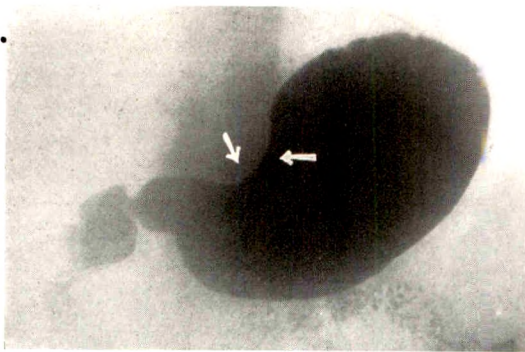


FIG. 4. Case II. Shows a small stomach with a persistent fixed area on the lesser curvature.

The following 6 cases are described which illustrate the diagnostic features of the roentgen changes observed in this group. Three additional cases have already been recorded.

CASE I. Mrs. J. K., aged fifty-two, complained of pains in her stomach, vomiting, pressure in epigastrium, weakness and lump in throat. Her stomach symptoms began five years ago, at which time she had two attacks of severe pain in the right upper quadrant, associated with fever, jaundice and nausea. These attacks were relieved by a gallbladder operation. The gallbladder was found to be filled with stones. The appendix was also removed. Since then she had been free of abdominal symptoms until about one year ago when she began to complain of vague abdominal pains, coming on about ten to thirty minutes after eating, which were relieved by taking soda. She has had a number of these attacks during the year and each time they became more severe. Pains, anorexia and loss of weight became prominent symptoms. She entered the Johns Hopkins Hospital for observation, where a complete study was made.

On physical examination the patient was

found to be acutely ill. The abdomen was slightly distended, liver edge palpable, spleen not palpable. No mass could be detected. Localized tenderness was elicited in the epigastrium. The roentgen examination (Figs. 1, 2 and 3) revealed an unusually small stomach, which emptied rapidly. Both curvatures showed a fixed, stereotyped appearance; the peristalsis was markedly diminished. No visible filling defect was observed. The duodenal bulb filled well. The roentgen changes in the stomach suggested an indurative lesion, probably malignant. The chest and long bones were negative. The interesting feature of this case is the blood picture. The blood revealed a reduction in erythrocytes, a reduction in hemoglobin, a progressive decrease in leucocytes a remarkably high percentage of myeloblasts in the differential count and a reduction in the platelet count. These blood changes are characteristic of a myelophthisic anemia and suggests a metastasis into the bone marrow. Clinically it was thought that this was a case of myelogenous leucemia. This pseudoleukemic blood reaction is not an uncommon observation in terminal carcinoma. Wassermann reaction was negative. Throat cultures and smears were negative. Gastric analysis revealed an absence of free hydrochloric acid and a total acidity of 6; no lactic acid; blood negative. The stools were watery and revealed occult blood. No autopsy was obtained in this case. The diagnosis was made from the roentgenological picture of an indurative lesion in addition to the absence of hydrochloric acid and the typical blood picture of a terminal metastatic carcinoma.

CASE II. Mr. M. L., aged fifty-six, has had stomach trouble for thirty years. Three years ago he developed gastric pains, coming on about three hours after eating, which were relieved by food and soda. His appetite then was good, but he complained also of considerable distention. These symptoms disappeared under treatment. One year later his digestive symptoms returned. At this time a roentgen examination (Fig. 4) of the gastrointestinal tract was made and revealed a small fixed area on the lesser curvature of the stomach; no filling defect could be detected; the pylorus was regular; the duodenal bulb was normal; the colon was also normal. A roentgen diagnosis of a gastric lesion was made. The fixed area being small in size, occupying the usual site of an ulcer, suggested the possibility of a benign lesion and the

patient was therefore placed upon an ulcer regimen following which all gastric symptoms disappeared.

Seven months later, he again developed stomach symptoms, and upon re-examination the roentgen ray revealed a large irregular annular carcinoma of the pylorus with a large eighteen hour gastric retention (Fig. 5). A fractional analysis made of the gastric contents revealed an absence of free hydrochloric acid and a total acidity ranging from 6 per cent on a fasting stomach up to 15 per cent after twenty minutes. No lactic acid was obtained; no occult or free blood was detected. Stools revealed two-plus occult blood. At operation a large carcinomatous tumor was found with metastasis involving the omentum, peritoneum and liver.

CASE III. Mr. A.E.L., aged fifty-four, complained for six months of pains in lower chest and poor appetite. A roentgen investigation of the digestive tract revealed a normal functioning gallbladder. The stomach showed a constant fixed area on the greater curvature. The pylorus was normal; duodenal bulb regular; colon normal. The changes in the stomach suggested a gastric lesion, but at this time this case could not be classified roentgenologically as either malignant or benign. Gastric analysis revealed a free hydrochloric acid of 26 and a total acidity of 50. He was placed on the usual ulcer treatment and the symptoms disappeared.

Eight months later the condition returned,

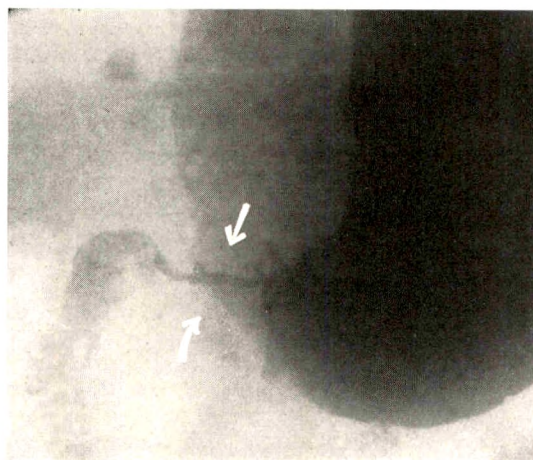


FIG. 5. Case II. A roentgenogram seven months later, showing a large annular carcinomatous filling defect at the pylorus, the lesion extending up into the antrum.

with an additional symptom of loss of weight. At this time a re-examination (Fig. 6) showed a small stomach, located high under the left diaphragm; it emptied rapidly; the curvatures



FIG. 6. Case III. Shows a carcinomatous irregularity in cardia of the stomach. Roentgenograms made eight months previously revealed a small fixed area on greater curvature suggestive of a gastric lesion.

showed a stereotyped or fixed appearance. The cardia of the stomach was narrowed and irregular; pylorus and duodenal bulb were regular; colon normal. A roentgen diagnosis of gastric carcinoma was made and at operation a large carcinomatous tumor was found. The gastric analysis at this time showed a free hydrochloric acid of 18 and a total acidity of 34. These high acid findings are not an unusual observation, especially in the early stages of carcinoma of the cardia of the stomach.

CASE IV. Mr. H.S.K., aged fifty-nine, complained of stomach trouble for seven months with abdominal pains, having no relation to food; poor appetite; slight difficulty in swallowing and slight loss of weight. A gastrointestinal roentgen investigation (Fig. 7) revealed a small, rapidly emptying stomach. A small fixed area was observed on the lesser curvature, but no typical filling defect of an organic lesion could be detected. The pylorus was regular; duodenal bulb normal; second portion of the duodenum was markedly dilated as a result of adhesions. A diagnosis of gastric lesion of undetermined nature was made. A test meal showed an absence of free hydrochloric acid and a total acidity of 21. His symptoms became progressively worse and about six months later an exploratory operation revealed a carcinoma of the stomach.

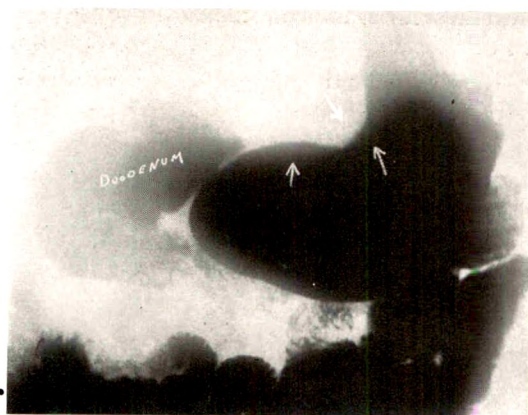


FIG. 7. Case IV. Shows a small stomach with fixed curvatures; empties rapidly. No demonstrable filling defect observed. Case proved to be a carcinoma.

CASE V. Mrs. C. J., aged forty, complained of indigestion for two years. Recently she began to lose weight, with abdominal distention, poor appetite, constipation and belching. She has had no pain and no vomiting. The gastric contents at this time revealed an absence of free hydrochloric acid and a total acidity of 18. A roentgen examination of the gastrointestinal tract showed an unusually small stomach, which emptied rapidly; the cardia appeared somewhat narrowed, but no typical defect could be detected (Fig. 8). The lesser curvature showed a fixed area suggesting a gastric lesion of the

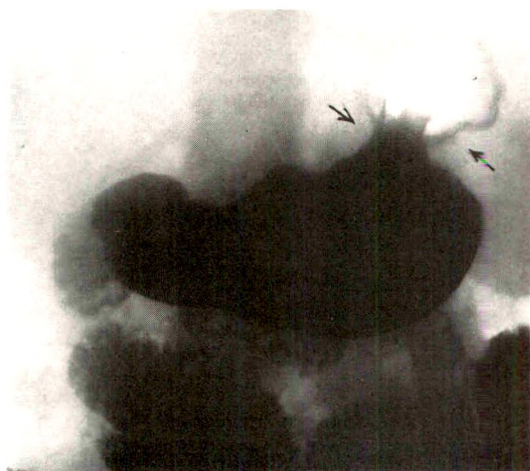


FIG. 8. Case V. Showed a small, rapidly emptying stomach, with narrowing of the cardia. Proved to be a carcinoma.

malignant type. At operation a carcinoma of the stomach was found.

CASE VI. Mr. T. D., aged forty-two, complained of recent pains in the epigastrium with no relation to food; poor appetite; a gnawing sensation in stomach, and constipation. A roentgen examination (Fig. 9) made at this time revealed a small stomach which emptied rapidly. The stomach had a fixed, stereotyped appearance, with definite lack of peristaltic movements. No definite filling defect was observed. The lesser curvature, however, showed a small straight line effect; the pylorus was found to be patent and regular; the duodenal bulb appeared moderately dilated; the second portion of the duodenum also revealed a slight dilatation. The roentgen changes in the stomach sug-



FIG. 9. Case VI. Showed a small rapidly emptying stomach, with a fixed area on lesser curvature. No demonstrable filling defect is observed. Proved to be a clinical case of carcinoma of the stomach.

gested a malignant condition without the usual characteristic filling defect. The patient died of a general carcinomatosis.

This group of cases was followed for many months and had been re-examined on repeated occasions. The diagnosis of carcinoma in the entire group was verified by either operative or clinical-roentgenological procedures. Six cases came to operation. The remaining three presented a definite clinical and roentgenological picture of carcinoma of the stomach with later development of palpable masses. The entire group of 9 cases died of a malignant condition.

CONCLUSIONS

An attempt is made to present the early roentgen findings in a group of cases in which the diagnosis of carcinoma of the stomach had been definitely established. These cases presented no demonstrable roentgen filling defect characteristic of carcinoma. The importance of the indirect or secondary roentgen signs, viz., changes in peristalsis, motility, contour and size of the stomach and their effect on the curvatures as revealed by means of serial roentgenography are stressed as early roentgen signs of gastric pathology. It is also pointed out that changes in the early stage of gastric disease may not be revealed

by the roentgenoscopic examination and that on this account serial roentgenography with careful study of the peristaltic waves along the curvatures is essential. In order to definitely establish the diagnosis, repeated roentgen examinations are often of the greatest value. A diagnosis of a gastric lesion is therefore at times possible many months preceding the visualization of a filling defect. From a study of this group of cases, I am thoroughly convinced that these roentgen signs, no matter how slight they may be, emphasize anew the increasing importance they command as a means of arriving at an early diagnosis of gastric carcinoma.



THE ROENTGENOLOGIC IDENTIFICATION OF COMMONLY ENCOUNTERED CHRONIC ULCERATIVE DISEASES OF THE COLON*

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IN THE north temperate zone three types of chronic, nonmalignant ulcerative disease of the colon are ordinarily encountered: diplostreptococcic, tuberculous and amebic. If other types occur they are rare, or their nature is not readily determined, so that for practical purposes they do not come under consideration before these three more prevalent types are definitely excluded in the diagnosis. It is often possible, from a carefully made clinical appraisal, not only to recognize the presence of one of these diseases, but to point to its probable etiology. But for a precise and conclusive diagnosis, the physician must resort to the objective data made available to him by one, not infrequently by all, of the three key diagnostic procedures essential to adequate rectal and colonic diagnosis: proctoscopy, gross and microscopic analysis of stools and rectal discharges, and roentgenologic examination. Of these, the last named is by no means the least important, for only a limited portion of the bowel comes within proctoscopic range, and examination of the stool and rectal discharges may fail to disclose significant findings. It is my purpose here to consider the roentgenologic methods of examination as applied to investigation of these diseases, to describe the roentgenologic manifestations of chronic ulcerative disease of the colon in general, and to point out roentgenologic characteristics which have been found useful in distinguishing these particular diseases of the large intestine from one another.

ROENTGEN METHODS OF INVESTIGATION

The observation of the opaque meal in its progress through the intestinal tract,

to study alterations in intestinal motility, has been advocated as a method of investigation particularly efficacious in this group of diseases. It is not the method of choice in the Section on Roentgenology in The Mayo Clinic, because of the conviction that the evidence of disease it delivers is largely indirect, and hence of diminished diagnostic value when compared with the direct evidence of disease elicited by other methods. A local or general increase in intestinal motility is to be expected in all types of chronic ulcerative colitis. If the ulcerative process is diffuse and extensive, transportation of the opaque meal through the large intestine is markedly accelerated. If, on the other hand, the disease involves only a relatively short portion of the bowel, the increase in rate of transportation is restricted to involved and immediately adjacent segments, whereas the unaffected intestine does not exhibit any acceleration in motility. Barger^{1,2} has repeatedly called attention to a noteworthy exemplification of this occurrence in cases of the diplostreptococcic type of ulcerative colitis, in which the disease is confined to the most distal segments of the bowel. Rectal discharges of pus, blood and mucus may be numerous, yet the patient may complain of constipation, and the stools may be scybulous. This indicates retarded colonic motility, in spite of ulceration and consequent hyperirritability of the involved rectum and sigmoid.

The phenomena of local or general hypermotility have never been looked on as intrinsically pathognomonic of any single type of ulcerative colitis. Even if considered in association with other relevant laboratory or clinical data, as for instance

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

the coexistence of an active focus of tuberculosis in the lungs, or the presence of *Endamoeba histolytica* in the stool, these phenomena cannot be said, in a strict sense, to constitute anything more than presumptive evidence of a specific disease. When rigidly controlled, however, as is the method of recognizing intestinal tuberculosis advocated by Brown and Sampson, roentgenologic evidence of local or general hypermotility is not easily disregarded.

In the Section on Roentgenology in The Mayo Clinic roentgenoscopic observation of the opaque enema is the cardinal procedure in investigation of all types of disease of the large intestine, malignant and benign. The requirements in individual cases may demand that examination of the colon be extended to include other roentgenologic procedures, of which the most commonly employed are roentgenography of the bowel distended with the opaque clysma, and special examination of the mucosa and the internal topography of the bowel by roentgenoscopic and roentgenographic examination after the opaque enema is evacuated, both before and after distention with air or some other inert gas. These are looked on as auxiliary maneuvers, which complement but do not supersede the roentgenoscopically controlled administration of the opaque enema. As a matter of principle, any method or combination of methods should be employed to make rendition of a complete and precise diagnosis possible. Roentgenoscopic observation of the opaque enema is designated the cardinal method, because from the diagnostic data it yields, the indications for extension of the examination to include more refined techniques can be inferred. The advantages it offers seem obvious. Exact information regarding mobility, flexibility, and the character and persistence of irregularities in contour is made available. The entire organ can be viewed as a unit in its living state, or any part of it can be subjected to separate visual and manipulative scrutiny at any instant, from any desired angle. In most instances of organic disease of the colon,

it is possible to elaborate a pathognomonic roentgenologic syndrome from the data elicited in this phase of the examination alone.

Any technique of administering the opaque enema for roentgenologic examination is permissible as long as it provides for visualization of every part of the large intestine, and permits simultaneous manipulation of the bowel whenever this is necessary or helpful. The technique in use at The Mayo Clinic has repeatedly been described.^{13,14} It is hoped that a word of exhortation about the preparation of the bowel for the examination will not be considered superfluous or out of place. It is important that even in the presence of severe ulcerative disease of the colon, with frequent stools, some special effort should be made to cleanse the lumen of the bowel of excessive quantities of gas, intestinal secretion, and fecal material. Paradoxical as it may seem, these are almost always present in the unprepared colon in quantity sufficient to interfere with securing ideal diagnostic results from the roentgenologic examination. Drastic catharsis is of course contraindicated if patients have active diarrhea, or if the ulcerative process is in an acute, fulminating stage. A mild, nonsaline cathartic drug, supplemented by a few warm enemas of physiologic saline solution, is a commendable preparatory measure.

ROENTGENOLOGIC DIAGNOSIS

General Considerations. Anatomically, chronic ulcerative colitis of any type produces some degree of narrowing, shortening, mural thickening, and mucosal destruction in the affected portion of the intestine. The intensity of the changes produced varies with such factors as the duration of the disease, its virulence, the general resistance of the patient, and the extent of secondary infection. The changes in the mucosa are macroscopically distinctive so that direct inspection of the mucosal aspect of the bowel usually, but not invariably, makes possible identification of the type of ulceration. The other macroscopic features,

on the other hand, are not essentially pathognomonic, since the pathologic processes by which they have been developed are essentially the same, whatever the etiology of the disease. If roentgenologic diagnosis is to have a rational basis, the signs elicited should reflect the anatomic changes produced as a result of, or in association with, the underlying pathologic process. Pathognomonic roentgenologic characteristics of the ulceration in the group of diseases under consideration have not, to my knowledge, been described. The alterations in the bowel that are roentgenologically demonstrable, however, are general contraction, which implies narrowing and shortening; mural thickening revealed by increased resistance to palpation; diminished mobility and flexibility, and destruction of the mucosa revealed by marked changes in its relief. Of invaluable differential diagnostic significance are such roentgenologically recognizable features as the site of apparent earliest and severest involvement, the dis-

tribution of the process and its method and direction of extension, the general intensity of the disease, and roentgenologic findings in other organs. The command, "Look at the four corners of the film," which is said to have been originated by Hickey, is particularly pertinent in the differential diagnosis of this group of colonic diseases.

Chronic Diplostreptococcic Ulcerative Colitis. The term "chronic ulcerative colitis" by which the disease is widely known is inadequate because not sufficiently specific. I use the word "diplostreptococcic" to specify that particular type of chronic ulcerative colitis with which Bagen's bacteriologic investigations have chiefly been concerned. Associated with this disease is a pathognomonic proctologic picture described in detail by Buie and others, and a roentgenologic syndrome which is no less characteristic and specific. Bagen has made out a plausible case for the specific etiologic part played by the diplostreptococcus he isolated and described, and his

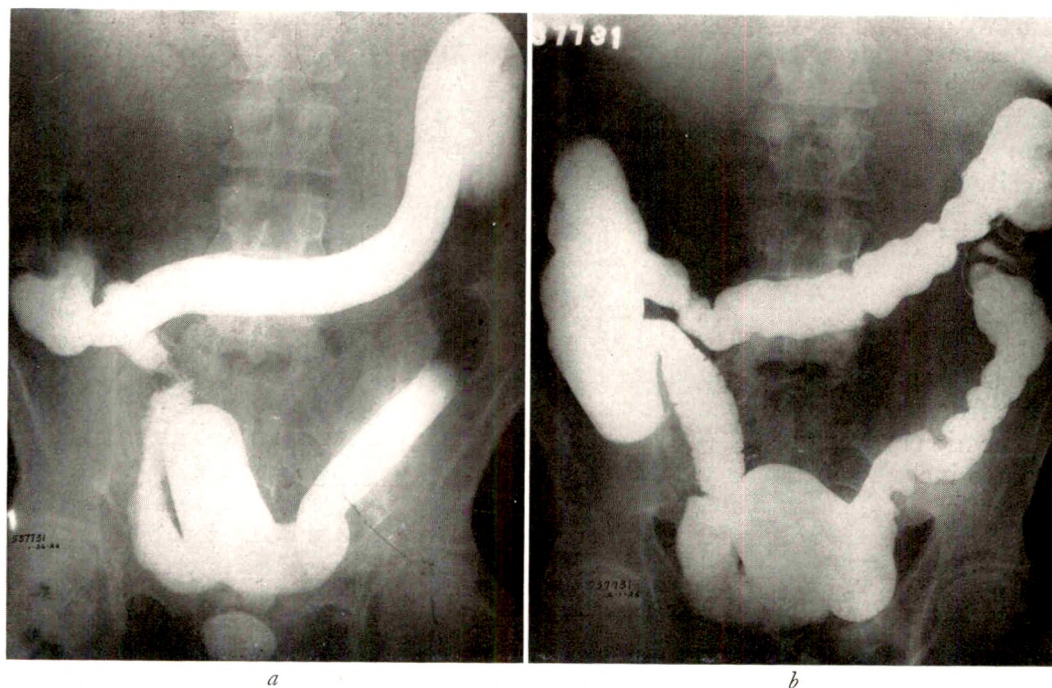


FIG. 1. Chronic diplostreptococcic ulcerative colitis. *a.* Narrowing, shortening, mucosal destruction and absence of haustral markings are characteristic of all ulcerative colonic disease; that the disease progressed orad from the rectum is characteristic of chronic diplostreptococcic ulcerative colitis. *b.* After treatment for ten months; the normal appearance is tending to return.

work is supported by Soper, Fansler, Jones, Torrey, Chisholm and others. It is also apparent, however, that other organisms, as secondary invaders, contribute not a little to the pathogenesis of the disease.

Since the rectum is the site of primary and severest involvement, the proctoscope delivers the most direct and reliable diagnostic information. Roentgenologic examination determines the extent of the process beyond the range of the proctoscope, reveals the presence or absence of complications, and offers the only objective evidence of the presence of the disease in those comparatively rare instances in which the rectum has not been primarily involved.

As has been stated, roentgenologic evidence of narrowing, shortening, mural thickening and mucosal destruction is common to all types of chronic ulcerative colitis. These changes are expressed more intensely, however, in the diplostreptococcal than in the other types. The severest involvement is seen in the most distal portions of the bowel, the rectum and sigmoid, and tends gradually to diminish in intensity from below upward. The manner in which the disease progresses proximal from the site of primary attack is vividly reflected in the roentgenologic picture, and this makes up one of the most important differential diagnostic features; in fact, it is the only morphologic differential characteristic when distribution of the disease is atypical. Characteristic of the diplostreptococcal type of ulcerative colitis is the diffuse, symmetrical involvement of the circumference of the bowel (Fig. 1) and a creeping, pedetentous, dogged type of advance from segment to segment. This is the pathologic background for the roentgenologic features of the disease: diffuse, concentric, uninterrupted, narrowing, shortening, thickening of the walls and mucosal destruction.

The disease is confined to the rectum in 20 per cent of the cases;³ the entire colon and terminal part of the ileum may be involved, or the advance of the disease may be checked at any point between the rectum

and cecum. Chronic diplostreptococcal ulcerative colitis, without rectal involvement, is found in scarcely more than 5 per cent of all cases encountered in The Mayo Clinic.

Smooth contours and subdued or absent haustral markings do not constitute an

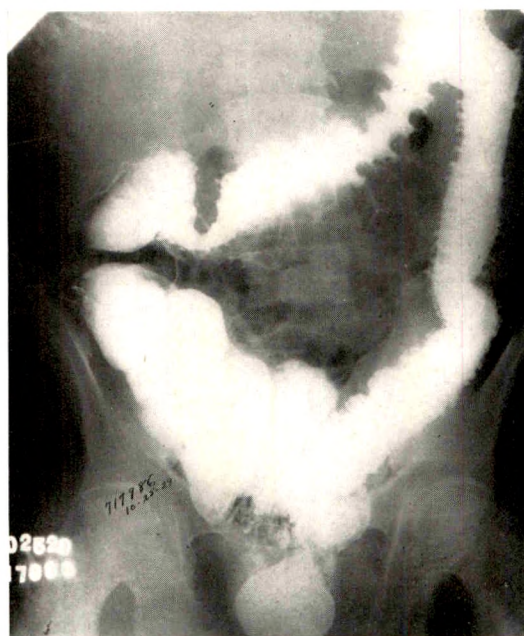


FIG. 2. Chronic diplostreptococcal ulcerative colitis, acute fulminating stage. Deep submucosal excavations are revealed by niche-like projections from the luminal shadow. Narrowing and shortening have not had time to develop.

adequate basis for a diagnosis of ulcerative colitis. It is true that the roentgenographic outline is unusually smooth and straight when the ulceration is granular and superficial, but when the ulcerative process extends deeper, and mucosal destruction is more severe, the contours are uneven, fringed, and feathery (Fig. 2). In the same way the mucosal surface may be very smooth and flat, devoid of every vestige of relief, or it may be irregularly corrugated, rough, and uneven.

The typical picture of this type of chronic ulcerative colitis has frequently been described. Rapid filling of the bowel by rectum and hyperirritability of involved seg-

ments are associated with the signs already considered. The course of the bowel has a tendency to lose its gently twisting character, and normal angulations at the flexures and elsewhere approximate right angles. Variations from the entirely typical picture are sometimes encountered, but, as a rule the roentgenologic picture is uniform, and

low ebb of the fecal current in this region, which enhances the organism's opportunity to gain a foothold. Tuberculous ulceration is most frequently found in the ileum, near the ileocecal valve, and may not extend into the colon. On the other hand, involvement may be confined to the cecum and proximal segments of the colon, with a sharp interruption of the process at the ileocecal orifice. However, combined involvement of the terminal portion of the ileum, cecum and ascending colon is by far more commonly encountered.

Early in its development the tuberculous intestinal ulcer is a discrete, circumscribed lesion. Extensive involvement seems to take place by development of multiple, separate ulcers with eventual coalescence, rather than by a creeping type of extension from a primary focus, as is the case with the diplostreptococcic type of chronic ulcerative colitis. The result is a tendency toward irregular involvement of the circumference, and an interrupted rather than continuous extension in the direction of the longitudinal axis of the bowel. It is probable that extension caudad takes place much more readily than retrograde extension; the diplostreptococcic type of ulcerative colitis, on the other hand, seems capable of extending in either direction with almost equal facility.

It is customary to distinguish between the hyperplastic and ulcerative types of intestinal tuberculosis. The former is often, the latter rarely, primary in the intestine. The hyperplastic type of intestinal tuberculosis is definitely a tumefactive, granulomatous process, localized to a relatively short portion of the bowel, usually to the ileocecal coil (Fig. 3), less commonly to more distal segments, and is formative rather than destructive. Sometimes, however, the predominance of the hyperplastic reaction is not so marked, and the tuberculous process exhibits so many elements of both forms, that a sharp line of distinction cannot be drawn. As a rule, however, the hyperplastic type of intestinal tuberculosis will demand differential identification from

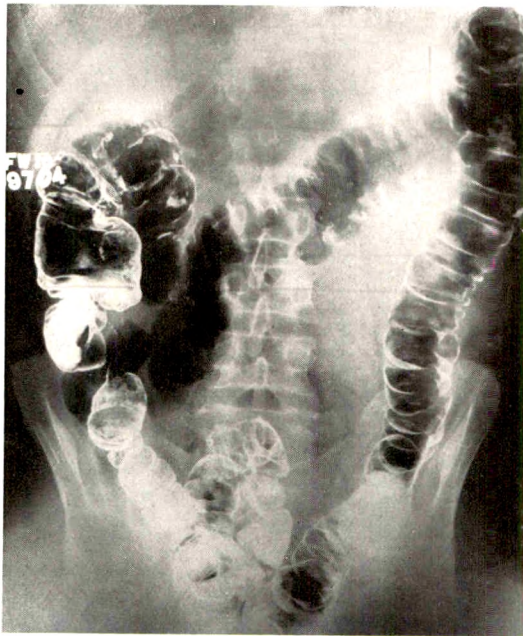


FIG. 3. Hyperplastic ileocecal tuberculosis revealed by the double contrast method. Deformity of the cecum and abrupt narrowing of the terminal portion of the ileum are evident. Diagnosis was confirmed at operation.

need practically never be confounded with that of any other known disease of the bowel.

Tuberculous Ulcerative Colitis. It is generally agreed that the ileocecal portion of the intestinal tract is the most common site of tuberculous intestinal involvement, and that the earliest lesions are invariably found there. Most observers suppose that the infection originates with ingestion of infectious tuberculous material. The predisposition of the ileocecal region seems to be associated with its abundance of lymphoid tissue, to which the bacillus of tuberculosis is notoriously partial, and with the

neoplastic disease and other forms of granulomatous involvement rather than from one of the types of chronic ulcerative colitis.

Secondary involvement of the intestine with tuberculosis from some distant, active focus, especially the lungs, is so common

(ulcerative) type of tuberculous enterocolitis has admittedly not been as large in The Mayo Clinic as elsewhere, but experience with other types of intestinal lesions makes me believe that evidence of anatomic change in the intestine can be elicited whenever such change is sufficiently exten-

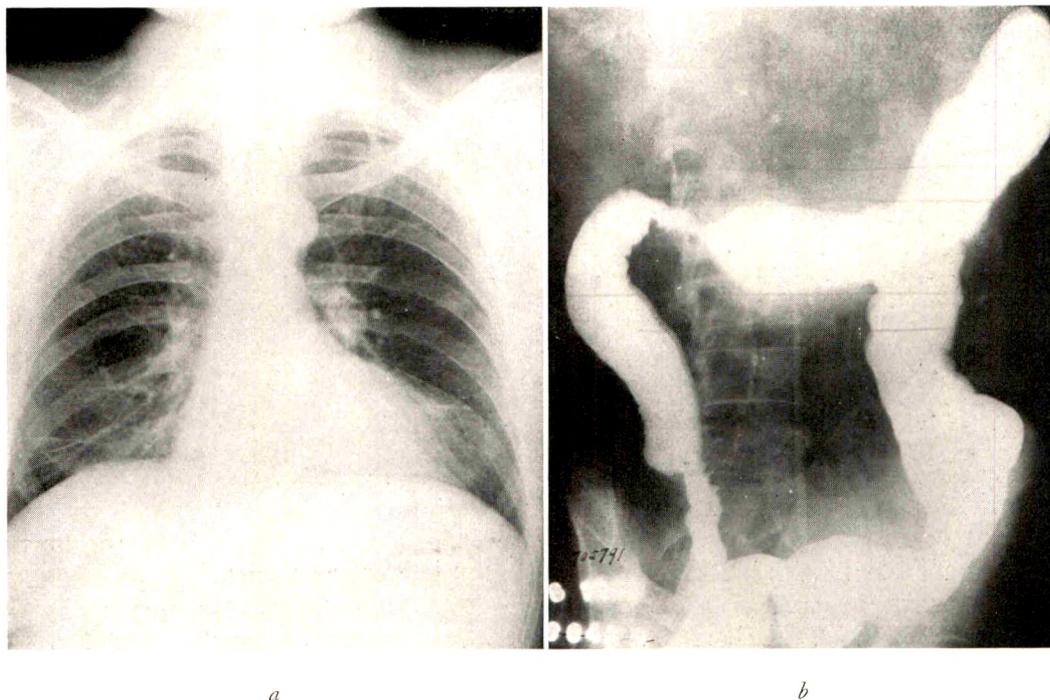


FIG. 4. Tuberculous ulcerative ileocolitis. *a*. The lungs in this case, contrary to the usual condition, are free of evidence of active tuberculosis. *b*. General evidence of ulcerative colonic disease is the same as that in Figure 1, but that the disease progressed caudad from the ileum is characteristic of tuberculous ulcerative ileocolitis. Diagnosis was confirmed at operation.

that any change, organic or functional, manifested in the intestinal tract, particularly in the ileocecal region, can perhaps more or less logically be interpreted as objective evidence of tuberculous involvement of that region. Foreknowledge of the existence of an active, primary tuberculous focus, therefore greatly simplifies the diagnostic problem. Sources of error, however, are numerous unless the evidence of intestinal involvement is carefully weighed and evaluated. Roentgenologic findings which mirror the anatomic changes in the intestine produced by the disease merit prime consideration. Experience with the secondary

sive to effect recognizable functional abnormality.

Since the combined involvement of ileum, cecum, and colon is so typical of a tuberculous process, it is essential to subject the ileum to thorough roentgenologic examination. This is accomplished in the most satisfactory manner, and usually with ease, by retrograde, opaque filling through the ileocecal valve. Contraction, hyperirritability, and obliteration of mucosal relief are the principal roentgenologic signs of disease of the ileum, and are usually seen in the very terminal segments. Narrowing, shortening, hyperirritability, and mucosal

destruction again bespeak cecal and colonic involvement (Fig. 4). If the evidence of disease is found distal to the hepatic flexure, a patchy distribution is not infrequently seen, with relatively unaffected portions of bowel interposed between diseased segments. The contours of the shadow of the barium-filled lumen may be smooth or uneven, depending largely on the depth of ulceration. Narrowing of the lumen is usually marked, especially if a long segment is involved; the shadow, however, is not straight and tubelike, but tends to be unsymmetric and sharply irregular. Normal mucosal relief patterns are, of course, obliterated in the affected segments, and a rugged, irregularly arranged grouping of jagged prominences and depressions takes its place.

These are the principal differential characteristics of the deformity produced in association with tuberculous enterocolitis. Of prime diagnostic significance, however, is the evidence of initial and combined involvement of ileum, cecum and proximal part of the colon, with diminution in intensity of the extending process as the rectum is approached, and on this basis alone the distinction from the diplostreptococcic type is possible in the vast majority of instances. The differential identification from amebic ulcerative colitis is a more difficult task.

Amebic Ulcerative Colitis. According to Craig, who cited the opinion of other authorities to substantiate his own, *Endamoeba histolytica* is not found in the stool except in the presence of an amebic intestinal lesion. The estimate that between 5 and 10 per cent of the population of this country harbor *Endamoeba histolytica* is said to be conservative. This represents a high incidence of amebic disease, and in this light the poverty of the roentgenologic literature on the subject is surprising. It is true that the disease, as encountered in this latitude, is in relatively attenuated form; still, amebic dysentery is not altogether uncommon, and it does not seem unreasonable to expect some roentgenologic evidence

of a lesion which is capable of causing such a degree of functional irregularity of the intestine.

The fact is that significant roentgenologic evidence of ulcerative colitis is elicited in at least some instances when *Endamoeba histolytica* is discovered in the stools, even in the absence of definite clinical evidence of intestinal disease. How uniformly this occurs cannot be stated at the present time, because the opportunity to examine all persons who harbor the parasite has not been offered. It is probable that positive roentgenologic findings will be found much more frequently than is suspected by many of those who deal with this group of patients clinically. If roentgenologic examination offered no more than objective evidence of the severity and extent of involvement, and of the effects of anti-amebic therapeutic measures, its application in all cases of amebiasis would seem justified. Not infrequently positive roentgenologic data will stimulate more intensive search for the causative parasite.

Anatomically, the cecum and proximal segments of the colon have been found to be sites where earliest and severest amebic ulceration is discovered. Secondary sites of preference are the dependent portions of the bowel. The ileum is notoriously free of involvement, although the cecal aspect of the ileocecal valve is frequently affected, which results in a gaping orifice due to stiffening of its lips. Essentially the same pathologic changes take place in the walls of the bowel as are seen in other types of ulcerative colitis, although the emphasis and degree of involvement displayed by other types at comparable stages are lacking. Extension of the disease beyond the site of primary involvement is not continuous, but tends to be interrupted, with the interposition of relatively unaffected segments between those that are diseased.

With this anatomic background, the roentgenologic diagnosis of amebic ulcerative colitis can be approached with reasonable hope of a measure of success. It is possible that roentgenologic evidence of

anatomic change in the colon will be discoverable among but a relatively small percentage of the carriers of *Endamoeba histolytica*, especially if minor deviations from normal roentgenologic appearances are permitted to pass unheeded.

The cecum demands particular attention (Fig. 5). It has been the site of maximal roentgenologic change in every instance in which I have offered a diagnosis of amebic ulcerative colitis. Suppression of haustral markings, shortening, and narrowing, sometimes to the extent of almost complete obliteration of the lumen, have uniformly been observed in the cecal segment. It does not seem that any degree of diagnostic significance should ordinarily be associated with so-called incompetence of the ileocecal valve. Slight manipulation of the ileocecal coil at the time when the cecum is moderately distended with the opaque enema usually effects reflux into the terminal part of the ileum. However, an unimpeded rush of opaque fluid ob-

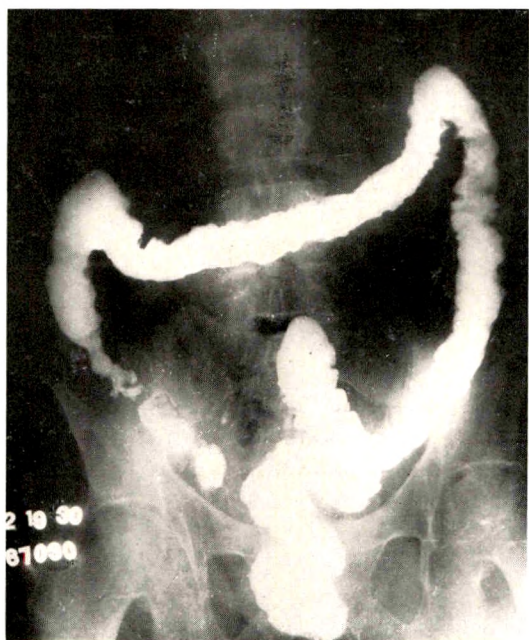


FIG. 5. Chronic amebic ulcerative colitis. Narrowing and shortening are confined to the cecum. The terminal portion of the ileum gave no evidence of organic change at roentgenoscopic examination. *Endamoeba histolytica* were found in the stool.



FIG. 6. Chronic amebic ulcerative colitis. Amebic ulcers were discovered in the rectum at proctoscopy, and *Endamoeba histolytica* were found in the stools. The general manifestations of chronic ulcerative colitis are apparent, but the intensity of the involvement decreases as the rectum is approached. Roentgenoscopically no evidence of disease was demonstrable in the ileum.

served to enter the ileum before even moderate distention of the cecum is accomplished is a signal for more than ordinary care in determining the presence or absence of cecal disease. With extension of the amebic ulcerative process beyond the cecum, the cardinal roentgenologic signs of ulcerative colitis are again exhibited, but not as emphatically as they are developed by the diplostreptococcic or tuberculous types (Fig. 6). Narrowing, shortening, and mucosal destruction are not so intense. The wall of the bowel is relatively pliant and freely movable. The entire roentgenologic aspect of the disease is one of diminished intensity and severity, when compared with the manifestations of the other types of chronic ulcerative colitis.

Because of the wide divergence of therapeutic measures applied in the manage-

ment of this group of diseases of the large intestine, it is particularly essential that an accurate etiologic diagnosis be established. No single, diagnostic method is capable of accomplishing this task unassisted in every case. Roentgenologic methods of investigation have an invaluable contribution to make to the diagnosis. Let roentgenologists and their medical and surgical colleagues attempt to appreciate

the full complement of the evidence which these methods of investigation applied to the large intestine are capable of yielding. Not that roentgenologic investigation should be permitted to supplant any part of the carefully elaborated clinical survey of the patient. Rather let the correct diagnosis be reached by careful marshalling and judicious analysis of all available pertinent data, to the ultimate benefit of the patient.

REFERENCES

1. BARGEN, J. A. The etiology and treatment of chronic ulcerative colitis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1926, 16, 10-16.
2. BARGEN, J. A. The treatment of chronic ulcerative colitis. *Minnesota Med.*, 1927, 10, 689-694.
3. BARGEN, J. A. The medical management of chronic ulcerative colitis. *Tr. Am. Gastro-Enterol. Ass.*, 1927, 145-159.
4. BARGEN, J. A., and WEBER, H. M. Regional, migratory chronic ulcerative colitis. *Surg., Gynec. & Obst.*, 1930, 50, 964-972.
5. BROWN, LAWRASON, and SAMPSON, H. L. *Intestinal Tuberculosis*. Second edition. Lea and Febiger, Philadelphia, 1930, 376 pp.
6. BUIE, L. A. Chronic ulcerative colitis. *J. Am. M. Ass.*, 1926, 87, 1271-1274.
7. CHISHOLM, A. J. Symptomatology and treatment in chronic ulcerative colitis. *Colorado Med.*, 1928, 25, 28-31.
8. CRAIG, C. F. The amebiasis problem. *J. Am. M. Ass.*, 1932, 98, 1615-1620.
9. FANSLER, W. A. Chronic ulcerative colitis. *M. J. & Rec.*, 1927, 126, 427-430.
10. JONES, D. F. The surgical treatment of chronic ulcerative colitis. *Tr. Am. Gastro-Enterol. Ass.*, 1927, 172-179.
11. SOPER, H. W. Chronic ulcerative colitis. *Ann. Int. Med.*, 1927, 1, 313-350.
12. TORREY, J. C. Bacteriology of the human colon with particular reference to ulcerative colitis. *Tr. Am. Gastro-Enterol. Ass.*, 1927, 129-135.
13. WEBER, H. M. Chronic ulcerative colitis: its roentgenologic manifestations. *Med. Clin. N. Am.*, 1930, 13, 1461-1472.
14. WEBER, H. M. The roentgenologic demonstration of polypoid lesions and polyposis of the large intestine. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1931, 25, 577-589.



DOUBLE PENIS AND DOUBLE BLADDER

WITH REPORT OF A CASE*

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DIPHALLUS, or duplication of the male external genitalia in whole or in part, is a relatively uncommon disturbance of development. In the medical literature, 3 cases were reported in the seventeenth century, 5 in the eighteenth, 22 in the nineteenth, and 15, including the case reported herewith, in the elapsed portion of the twentieth century. This total of 45 cases observed in a span of nearly 325 years probably does not represent with any great degree of accuracy the actual number of occurrences of this monstrosity, since this malformation is one over which an individual would tend to preserve an air of secrecy. It is equally true, however, that there must have been few cases observed which were not reported.

The first recorded case of diphallus was described in 1609 by J. J. Wecker²⁶ and was mentioned again in the same year by Schenkus.¹⁸ Neugebauer¹⁵ published in 1898 an excellent discussion of this malformation briefly summarizing all of the cases that had previously been reported. There were 28 cases in this series. Since that time 16 cases have been reported and inasmuch as no complete compilation of these has been made, we shall briefly summarize them herewith.

CASE 29. Volpe.²⁵ See below.

CASE 30. Keppel⁸ reported a case of diphallus in a young male, aged twelve. Both penes were complete. The left was used for the sexual act, and the right for micturition.

CASE 31. Beck's case,² observed in a five weeks old child, had two penes springing from one stalk at the symphysis. There were two meati, but no true urethrae. Erectile tissue was present in the penes. The scrotum was divided into two lateral compartments by a broad scrotal raphe. There was an associated exstrophy of the urinary bladder with a pair of functioning ureteral orifices on either side of the trigone.

CASE 32. Lorthioir¹³ reported a case of complete

double penis. Each had a urethra and each was capable of erection. The scrotum was bifid but neither testicle had descended.

CASE 33. Heller⁷ described a case in which a double glans penis arose from a single shaft. These contained blind meati. A hypospadias was present under the right false meatus. The scrotum was normal, and no anomaly of internal organs was noted.

CASE 34. Ribera¹⁷ See below.

CASE 35. Lioni¹⁷ reported a case of double glans penis, the left meatus being impermeable, and the right leading through a single urethra to a normal bladder. The scrotum and its contents were normal.

CASE 36. Trenkler²² observed a case of double penis in which the corpora cavernosa were separated widely by a midline fault of the corpus spongiosum urethrae so that the urethral orifice lay in the perineum at the apex of the angle formed by the diverging corpora cavernosa. Each glans was nearly perfect. The scrotum and its contents were normal.

CASE 37. Vaudeschal's case²⁴ had a balanic hypospadias on the left. On the right of the midline was a supernumerary penis with a blind meatus. The scrotum was bifid, the right compartment containing no testis. The pelvic viscera were normal.

CASE 38. MacLennan¹⁴ reported a case of complete hypospadias over which hung a duplication of the glans penis. There was one scrotum containing two testes. The bladder sphincter was active and there was no incontinence of urine. An abnormal mass of tissue lying below the hypospadiac urethral orifice was found to be rectal epithelium.

CASE 39. Bruni.⁴ See below.

CASE 40. Bókay³ described a case of exstrophy of the urinary bladder with total epispadias. There was a double glans penis, the right exhibiting neither meatus nor urethra, and the left containing a meatus without underlying urethra. The scrotal raphe was broad, dividing the sac into two lateral compartments, each of which contained a testis.

CASE 41. Kimura's case⁹ was a newborn with atresia ani and cor biloculare in addition to a duplication of the glans penis on a single shaft which internally contained two reduplicated shafts (i.e., four corpora cavernosa and two corpora spongiosa urethrae). The double urethrae became fused to form one passage in the region of the colliculus seminalis. The scrotum was tripartite, with a testis in each of the lateral compartments, and an empty pouch posteriorly. The bladder, prostate and seminal vesicles were normal.

CASE 42. Tschmarke²³ described a case which pos-

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sessed two complete penes, of which the right alone contained a complete urethra and was capable of erection and ejaculation. The left glans had a blind meatus and no prepuce. The scrotum was divided incompletely into a semblance of two sacs, each of which contained a testis. The left side of the prostate was larger than the right.



FIG. 1.

CASE 43. Harrenstein⁶ reported a case in which there were two completely formed penes, each containing a urethra which led to a common bladder. Between the penes lay one compartment of the scrotum containing a testis. To the right of the right penis lay the other half of the scrotum with no contained testis. There was believed to be only one prostate.

CASE 44. Seth and Peacock,¹⁹ have recently reported a case in which the right penis was fully formed with prepuce, meatus, and urethra demonstrating slight hypospadias. There was no prepuce or urethra on the left, but there was a rudimentary meatus. The scrotum was single, containing both testes. Both penes became erect with sexual excitement. Pyelograms suggested a bifid right renal pelvis. Roentgenograms of the spine demonstrated several anomalies; lumbarization of the first sacral segment, congenital non-union of the lamina of the first sacral vertebra, and a right first lumbar rib.

Case 45 is described herewith:

CASE 45. R.S., No. 181994, a white male, aged six, is a child of apparently healthy parents. Six siblings are living and well. There were three miscarriages in addition, the last one a seven-month fetus with atresia ani. At the time of the birth of our patient, the at-

tending physician believed the child to be a female because of the marked edema of the perineum, and the child was given a female name. At the age of one year he was brought to the University Hospital for the first time, and on that admission the correct diagnosis of diphallus was made. The general physical examination is negative for other anomalies. Routine blood and urine studies are in no way abnormal. The blood Kahn is negative. The blood non-protein nitrogen value is 27.5 mg. per 100 c.c.

Examination of the genitalia (Fig. 1) reveals a duplication of the glans penis on a single stalk which measures 1 cm. in length. The glands are symmetrical, perfectly formed, but contain rudimentary meati which admit only the tip of a probe. Each glans is provided with a frenum. One prepuce encircles the two glandes. There are two corpora cavernosa, the extremity of each being capped by a distinct glans. The scrotum is widely cleft, encircling the penis above, and curving down laterally in the form of an inverted U. The lateral pouches each contain a single testis which lies considerably below the tendon of the musculus adductor longus. Between the base of the penis and the anal margin there is an irregular mass of tissue. Near the lateral borders of this mass and immediately below the root of the penis is a narrow cleft on each side which admits a No. 16 catheter (Fig. 2). The catheters traverse a course inward and mesially for a distance of



FIG. 2. Catheters have been inserted in the urethral clefts.

2 cm. and open respectively into distinct right and left urinary bladders. Below the level of these orifices, and set just off the midline in the midst of the perineal mass of tissue on either side are pinpoint openings which are apparently the orifices of the ejaculatory ducts. An elevation occupies the midline below these openings. Rectal examination confirms the suspicion

thus is composed of the elements of periprostatic urethral structures.

This is the sixth case of associated diphallus and doubling of the urinary bladder where no demonstrable connection between the two bladders could be made out. It is the first case of diphallus associated with

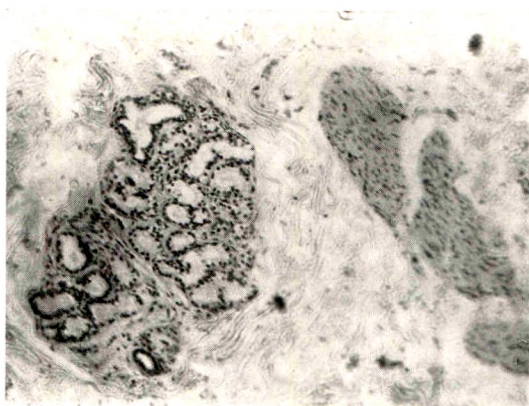


FIG. 3. Biopsy material demonstrating a nest of glands of paraurethral type. The epithelium is low columnar with basally placed nuclei.

that this elevation is the prostate gland lying on the perineum. The rectal sphincter is intact. The patient is likewise continent of urine, voiding two simultaneous streams at will.

Cystoscopic examination reveals that each bladder is a distinct organ, with no intercommunication between the two. The bladder mucosa appears normal and the single ureteral orifice in each bladder is normal. There is no trigone in either bladder. A No. 5 olive tip ureteral catheter passes easily to the renal pelvis, and retrograde pyelography with the aid of organic iodide demonstrates no abnormality of the upper urinary tract. Cystographic studies demonstrate the duplication of the urinary bladder and the imperforate midline septum (Fig. 5).

The ovoid prominence seen on the right at the lower border of the perineal mass (Fig. 1) was removed for pathologic study. This was reported as "stratified squamous epithelium underlaid by numerous bundles of smooth muscle; also numerous small glands of paraurethral type, some of which are mucin-forming" (Fig. 3). A small tag lying in the midline posteriorly was excised. This proved to be rectal mucous membrane (Fig. 4). The perineal tissue



FIG. 4. The greater portion of the perineal mass is covered by a simple columnar glandular epithelium resembling rectal mucous membrane.

duplication of the urinary bladder in which the latter has been demonstrated roentgenographically.

The first case of this type was described by Smith²⁰ in 1878, and was included in Neugebauer's concordance of 28 cases of diphallus. There were in this instance two well-formed penes, each with a perfect urethra which led to symmetrically disposed bladders which had no intercommunication. The right bladder contained a calculus.

The second case was described by Lange¹⁹ and was also included by Neugebauer. This was seen in a fourteen-day old child with atresia ani and double penis. The scrotum was divided into two parts by a broad scrotal raphe, and each sac contained one testis. The penes were well formed, and each had a normal urethra. At autopsy, the bladder appeared fusiform, and upon opening it, there was found a perfect division into two vessels which lay side by side and did not intercommunicate. In this septum lay the prostate and seminal vesicles. The ureters and kidneys were normal. From each bladder led a single urethra through its own penis. These urethrae did not intercommunicate at any point, but below the prostate there were individual communications between these and the rectum so that both feces and urine were emitted from the urethral meati.

Volpe²⁵ cited a variation of this severe form of dis-

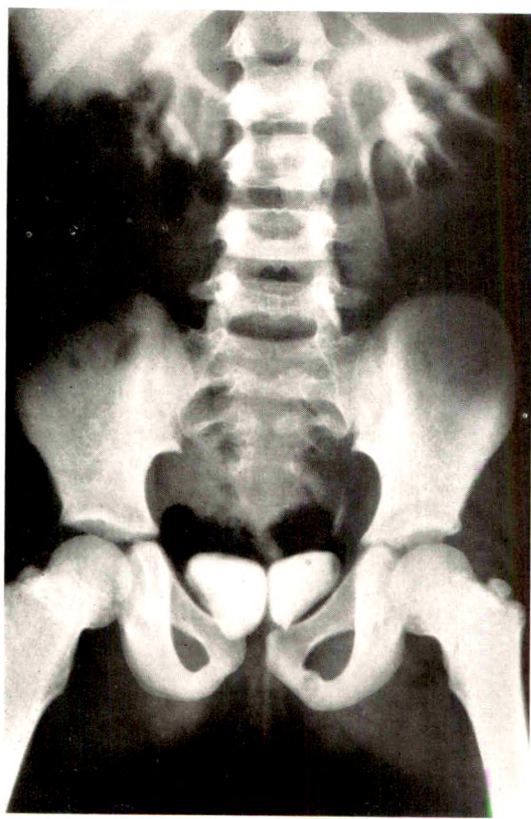


FIG. 5. Roentgenographic demonstration of the double bladder following intravenous urography.

turbance. There were two penes, completely formed and lying side by side. Each was provided with a urethral meatus and a single urethra which led to a distinct bladder. There was but one kidney and ureter and this latter opened into the left bladder. There were two suprarenal capsules. There was a complete duplication of the colon, beginning at the ileocecal valve region. One colon opened into the right bladder, the other into the left. The scrotum was bifid but hung in the perineum. There was no testis on the right. Each penis was composed of two corpora cavernosa and one corpus spongiosum. There was no anal orifice. Lebrun¹¹ observed that this was a most exceptional case in that it presented a fusion of organs normally doubled, and a doubling of organs which are normally single.

The fourth case (Ribera¹⁷) presented two fully formed penes one lying above the other. Each was provided with separate urethral meati, urethrae, and bladders, between which there was no communication.

Bruni⁴ added a further case, observed in a thirty-five year old male. There were two distinct penes, lying side by side, but possessing a half-cylindrical form. Each was provided with a meatus and a single

urethra through which a No. 16 sound could be passed to distinct bladders lying to the right and left of the midline respectively. On each side there was a single kidney and ureter which led to the homolateral bladder. The scrotum was widely cleft and each compartment contained a testis. The anal orifice was represented by two distinct openings lying to the right and left of the midline. The prostate and seminal vesicles were normal, but the latter contained no spermatozoa.

An understanding of these developmental anomalies requires an analysis of the embryologic origins of the parts involved.

The primitive gut is divided into several regional parts, and from the terminal one of these, the hind gut, there grows ventrally an evagination into the belly stalk which is destined to become the allantois. That portion of the hind gut caudal to the allantois dilates to form the cloaca. The cloaca is separated originally from the outside by a doubled layer of epithelium, ectoderm on the outer side, and entoderm facing the cavity of the cloaca. Between the two layers of epithelium of the cloacal membrane there grows from the intermediate cell mass of each side a proliferation of mesodermal cells. These mesodermal components are the anlagen of all the mesodermal structures of the lower abdominal wall; the striated musculature, the vessels, the cutis, and the differentiated group of cells which coalesce at the ventral midline to form one genital eminence—the anlage of the penis. It becomes obvious that any failure of coalescence of the rudiments derived from the two sides will result in a failure of formation of this one genital eminence. The normal development of this single genital eminence is essential to the later development of a normal single penis. Ballantyne¹ published the picture of a fetus with gastroschisis and two genital eminences widely separated, unquestionably the end-result of the failure of midline fusion.

The cloaca is gradually separated into two parts by the invagination of its lateral walls. The larger ventral division becomes the urogenital sinus, and the smaller posterior one the rectum. When this division is complete, the partition is the urorectal

fold, and into it are imbedded the terminal collecting ducts of the mesonephros. The formed urinary bladder is not, as would be supposed, the developmental end-product of the urogenital sinus or the allantois.¹⁶ It is, along with the ureters, the trigone, the prostatic urethra, the seminal vesicles and the ejaculatory ducts, the structural remains of the mesonephric duct system. There is one mesonephric duct (Wolffian) on each side. From each duct develops the bilateral structures enumerated above. It is the complete fusion of the vesical portion of the mesonephric ducts which produces the normal single urinary bladder. Any degree of incomplete coalescence produces the structural end-picture either of hour-glass bladder, incompletely bifid bladder, diverticulum with one ureter opening into the diverticulum, or, as our case represents, completely doubled bladder.²¹

Below the forming genital eminence, the rudiment of the lower anterior abdominal wall breaks in the midline to produce a defect in the ventral boundary of the urogenital sinus. This is the primitive urogenital opening. As the genital eminence develops, this cleft is elongated and its slit-like lips are in part brought into apposition in the midline again so that they normally fuse in the greater part of their extent. The failure of fusion of these lips in greater or lesser degree results in hypospadias. Epispadias and extrophy, on the other hand, are the results of failure of fusion of the cloacal membrane or its breaking down. The separation of the symphysis concomitant with exstrophy means simply that the mesoderm of the somatopleure which normally grows between the two layers of

the cloacal membrane failed to differentiate normally.

To recapitulate, the entire urogenital tract, with the exception of the apex of the bladder derived from the urogenital sinus (and even this is capable of midline defect) is derived from bilateral anlagen which by their fusion in embryonic life produce normally single end-products, the urinary bladder, the prostatic urethra, and the penis. Failure of this fusion inevitably results in varying degrees of reduplication of the organ in question. Double penis and double bladder become, from this ontogenetic point of view, the normal end-result of normal development of abnormally, incompletely fused anlagen.

The suggestion that double penis may be an atavism inasmuch as all snakes and lizards normally possess two complete external genitals is hard to appreciate in a serious light, for the crocodiles, an equally old line from the evolutionary point of view, present one single external genital.

Quite another point of view is represented by that of Taruffi²¹ who holds that this anomaly is a teratoid structure classified among the double monsters. His hypothesis, that the pelvis in these cases is really two pelves and the sacrum the fusion of two sacra, is not supported by either roentgenographic evidence of widening of the sacrum or anatomic proof of such coalescence. No case included in this survey gives weight to the notion that double penis is a disomatous teratoid structure.

One might also look on this anomaly, as does Ballantyne, as a minor degree of duplication of the individual. This places double penis in the same classification with supernumerary digits.

REFERENCES

1. BALLANTYNE, J. W. *Manual of Antenatal Pathology and Hygiene*, 1905, p. 544 et seq.
2. BECK, C. A case of double penis, combined with exstrophy of the bladder and showing four ureteral orifices. *Med. News*, 1901, 79, 451.
3. BÓKAY, J. Ueber Diphallie. *Jahrb. f. Kinderh.*, 1930, 127, 127-136.
4. BUNNI, C. Seltene Anomalie der Urogenitalorgane: doppelter Penis. *Ztschr. f. Urol.*, 1927, 21, 193-195.
5. CATHELIN, F., and SEMPÉ, C. La vessie double. *Ann. d. mal. d. org. génito-urin.*, 1903, 21, 339-358.
6. HARRENSTEIN, R. J. Ein Fall von doppelter Entwicklung des Penis und Skrotums (Diphallie). *Beitr. z. klin. Chir.*, 1931, 154, 308-314.

7. HELLER, J. Zwei seltene Missbildungen des Penis; a) Diaphallus partialis, b) Verdoppelung der Harnröhre. *Ztschr. f. Urol.*, 1908, 2, 612-617.
8. KEPPEL, J. W. A double penis. *N. York M. J.*, 1898, 68, 710. *Progres méd.*, 1899.
9. KIMURA, H. On double penis and its complications. *Japan M. World*, 1930, 10, 63-66.
10. LANGE, M. Ueber complete Verdoppelung des Penis, combinirt mit rudimentärer Verdoppelung der Harnblase und Atresia ani. *Beitr. z. path. Anat. u. z. allg. Path.*, 1898, 24, 223-230.
11. LEBRUN, Les urètres doubles. *J. d'urolog. méd. et chir.*, 1912, 2, 381-412.
12. LIONTI, G. Ein Fall von Penisverdoppelung. *Deutsche med. Wchnschr.*, 1914, 40, 393.
13. LORTHOIR, J. Un cas tératologique rare. *J. de chir. et ann. Soc. belge de chir.*, 1901, 1, 82-84.
14. MACLENNAN, A. Double penis. *Glasgow M. J.*, 1924, 101, 287.
15. NEUGEBAUER, F. L. *Monatschr. f. Geburtsh. u. Gynäk.*, 1898, 7, 550; 645.
16. PRENTISS, C. W., and AREY, L. B. Textbook of Embryology. Third edition, 1923, p. 206 et seq.
17. RIBERA, J. Acad. Roy., Madrid, March 4, 1911.
18. SCHENKLIUS, J. G. Monst. Hist., Francofurti 1609, 43.
19. SETH, R. E., and PEACOCK, A. H. Double penis. *Urol. & Cutan. Rev.*, 1932, 36, 590-592.
20. SMITH, A. P. *Tr. Med. & Chir., Fac. of Maryland*, 1878, 91.
21. TARUFFI. Sull'ordinamento della teratologia, Bologna, 1896.
22. TRENKLER, R. Ueber einen Fall vorkommener angeborener Penissspaltung (Doppelpenis). *Wien. med. Wchnschr.*, 1914, 64, 1079-1082.
23. TSCHMARKE, G. Beitrag zur Kasuistik der Di-phallie. *Beitr. z. klin. Chir.*, 1931, 151, 631-637.
24. VAUDESCAL. Présentation d'un cas de malformation rare des organes genitaux externes (Di-phallus). *Bull. Soc. d'obst. et de gynéc. de Par.*, 1921, 10, 271-273.
25. VOLPE, M. Dell' asta doppia. *Policlin.*, 1903, 10, (sez. chir.), 46-52.
26. WECKER, J. J. Obs. med. rar. admirab. et monst., Francofurti 1609. Lib. 4. De partibus genitalibus. Pene gemino visus quidam. 577.



TRAUMATIC CYST OF THE PANCREAS WITH INFILTRATION INTO THE WALL OF THE STOMACH CAUSING PYLORIC STENOSIS

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CYST of the pancreas is of such infrequency that few clinical studies of large series of cases have been reported in the literature. Judd states that of 723,397 patients admitted to the Mayo Clinic only 38 with cyst of the pancreas have been operated on. Körte in 1898 reviewed 121 cases from the literature.

Cyst of the pancreas may be found in almost any part of the abdominal cavity. Martin reported one behind the descending colon. In Judd's series one was found in the pelvis between the layers of the mesocolon and the sigmoid. Hulke cites a case in which the cyst was retroperitoneally burrowing toward the pelvis. Judd states that the most frequent location is in the lesser peritoneal cavity presenting between the stomach and the transverse colon and behind the gastrocolic omentum. The next most frequent site is between the stomach and the liver or protruding into the lesser peritoneal cavity behind the stomach.

In the diagnosis of cyst of the pancreas the character and the situation of the tumor are of great importance. The cyst usually presents as a smooth, hemispheric, more or less immobile mass with rather tense walls and situated between the ensiform cartilage and the umbilicus, usually in the midline or slightly to the left. In the 121 cases reviewed by Körte a tumor was felt in 114, sixteen of which were below the umbilicus. In Judd's series of 47 cases a tumor was felt above the umbilicus in 45.

Unless the cyst is in the tail of the pancreas, and even here adhesions may prevent mobility, it is as a rule immobile. Judd reports mobility in 11 of his 47 cases, 9 of which originated in the tail of the pancreas. A majority of the patients complain of a mass or a fullness in the upper abdomen. There may be a history of sudden

or of slow development. Judd states that in 43 of his 47 cases there was pain and that in 24 of these cyst of the pancreas was the only lesion found. The pain may be acute or dull. From the usual location of the cyst it is to be expected that nausea, vomiting and jaundice would be frequently encountered. In the review of the literature by Körte, jaundice was reported in 9 of the 121 cases. Judd reports a history of jaundice in 13 of his 47 cases.

In the differential diagnosis, cysts of the liver, the spleen, the ovary, the omentum, and the mesentery, hydrops of the gallbladder, tumors of the kidney, retroperitoneal tumors and aortic aneurysm have to be considered.

In cyst of the liver there is a swelling in the upper abdomen which is continuous with liver dullness; this is also true of hydrops of the gallbladder, whereas in cyst of the pancreas there is usually a line of resonance between the cyst and the liver. Cholecystography is also a differential aid in many instances.

In cyst of the pancreas there is usually an area of resonance between this and the spleen to differentiate it from a cyst of the spleen. In large cysts of the ovary the history is often an aid in the differentiation since the ovarian cysts grow from below.

Since the body of the pancreas usually lies just behind the stomach on the level of the first lumbar vertebra it can be readily understood why a severe blow in the upper abdomen could cause damage to this organ. There was a definite history of injury in 23 of the 121 cases reviewed by Körte. In Judd's series of 47 cases reported in 1930 there was a definite history of injury preceding the onset of symptoms in 8 cases. The time limit between the accident and the onset of symptoms varied

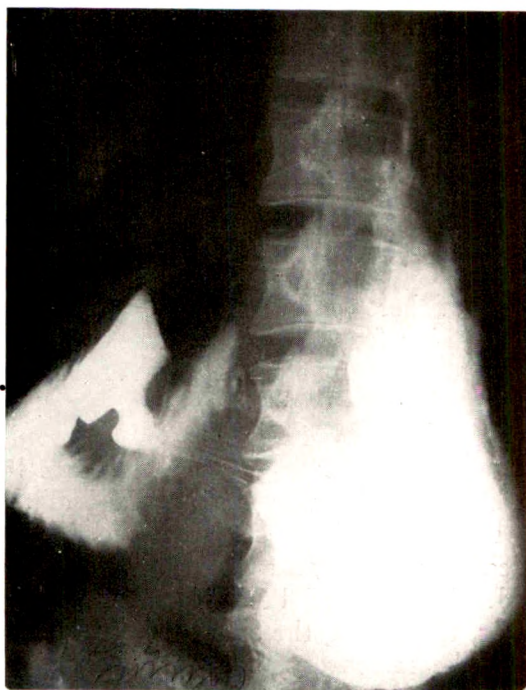


FIG. 1. Roentgenogram showing gross defect in pyloric end of stomach.

from three days to six years. McWhorter reports that there was a history of abdominal injury in 15 per cent of the cases. Lazarus produced a hematoma by crushing the pancreas of a dog and six weeks later found a cyst "the size of a goose egg," containing a milky fluid. Warnock reported a pancreatic cyst in a boy seven years of age following a severe abdominal trauma. There does not seem to be any reasonable explanation for the latent period in the development of cyst following trauma. Mahorner suggests that after the injury to the pancreas and the initial hemorrhage, the ferments erode the tissue causing further hemorrhage and thus enlargement of the cyst. This suggestion may explain the formation of the cyst in the case here reported.

CASE REPORT

Mrs. C. E. E., aged twenty-seven, was sent in for roentgenologic examination of the gastrointestinal tract on October 7, 1931, at which time she gave a history of having received an

injury on July 4, 1931, when she was jammed, while swimming, by a surf board just below the costal margin. This was followed by nausea and about an hour later by intense abdominal pain. An abdominal operation was done within six hours after the injury. The tissues around the lesser border of the stomach were found lacerated but the stomach had not been punctured. There was a steady improvement for six days following the operation when the lower part of the incision began to drain pancreatic fluid. The drainage was intermittent, sometimes none appearing for several days. It was noted that each time the drainage stopped the patient had intense pain in the right lower quadrant which was relieved when the drainage started again. Following long periods of drainage the patient would become very weak and nauseated. This was relieved by giving glucose in Ringer's solution intravenously. There was marked and almost constant tenderness in the epigastrium.

Examination showed a scar in the upper portion of the abdomen, a little to the right of the midline; beneath it was a mass that was well circumscribed, quite tender and not movable. There was no evidence of a pancreatic fistula.

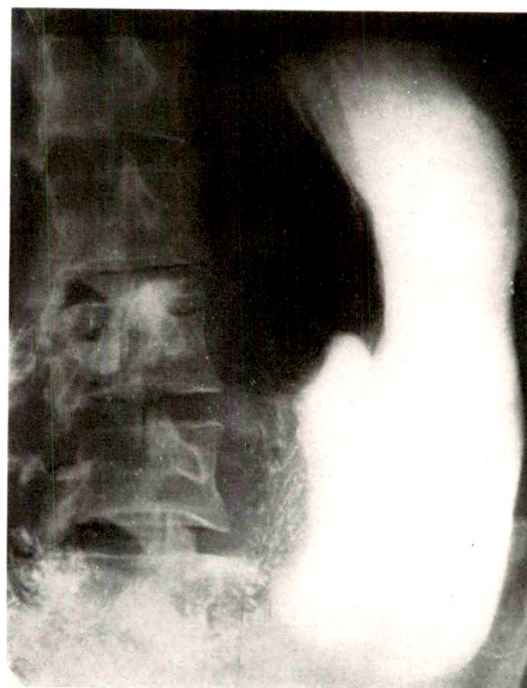


FIG. 2. Semilateral view of stomach which shows a smooth type of defect involving the pyloric antrum.

The report of the roentgen examination at this time was as follows: "A plain film of the abdomen shows a mass in its upper mid-portion. On fluoroscopic examination the pyloric end of the stomach is fixed and shows an annular gross defect which involves the stomach from the pylorus upward for about 8 cm. The defect is smooth in outline and gives the impression that the stomach is being tightly grasped by an extragastric tumor. No gastric lumen could be demonstrated in this area except by turning the patient toward the left and forcibly criving the meal through the pyloric antrum. There is about a 60 per cent gastric retention after six hours and a small retention after twenty-four hours. Believe she has either an extragastric tumor, probably a pancreatic cyst, but the marked retention, the pyloric fixation and the very small gastric lumen may mean that the wall of the stomach itself is involved."

Operation was performed on October 10, 1931, by Dr. J. Shelton Horsley of Richmond. On entering the peritoneal cavity a bluish walled cyst was encountered. This was opened, and the contents were removed with a suction apparatus. The cyst contained about a quart of clear, slightly viscid material. It was apparently not infected. The cyst wall was made up of parietal peritoneum and of part of the transverse colon and the transverse mesocolon.



FIG. 3. Lateral view showing a change in the type of defect and a small lumen.

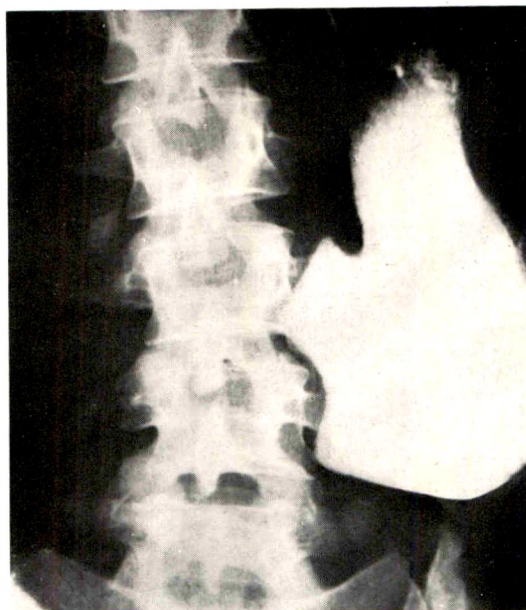


FIG. 4. Six-hour film showing definite retention.

It had infiltrated the posterior wall of the stomach, separating the muscular from the sub-mucous coat. This infiltration was extensive, involving all of the posterior wall of the stomach and the injury to the pancreas was behind the stomach. It seemed best therefore to excise the stomach, as probably there had been too much damage to its wall to permit recovery. The gallbladder was adherent at one point, and the adhesions were separated. The gallbladder was not removed, as it contained no stones and it was thought that the adhesions were due to the inflammation of the pancreas and stomach. The specimen showed that the posterior wall of the stomach had been infiltrated and constituted a part of the wall of the pancreatic cyst. This appeared to have begun at the lesser curvature and infiltrated within the stomach wall, separating the muscular coat from the mucosa and appearing at the lower border of the stomach where it penetrated the muscle and a temporary cyst wall was formed and became adherent to the anterior abdominal wall. The gastric mucosa was congested and showed numerous points of erosion but there was no definite ulceration.

COMMENT

The case reported not only presents many of the usual findings of a pancreatic cyst but also some unusual ones.

From the roentgenologist's viewpoint, the defect in the pyloric end of the stomach, with both six and twenty-four hour retention was somewhat suggestive of ma-

At operation it was shown that the defect was due to a pancreatic cyst which had infiltrated into the wall of the stomach beginning at the lesser curvature, involv-

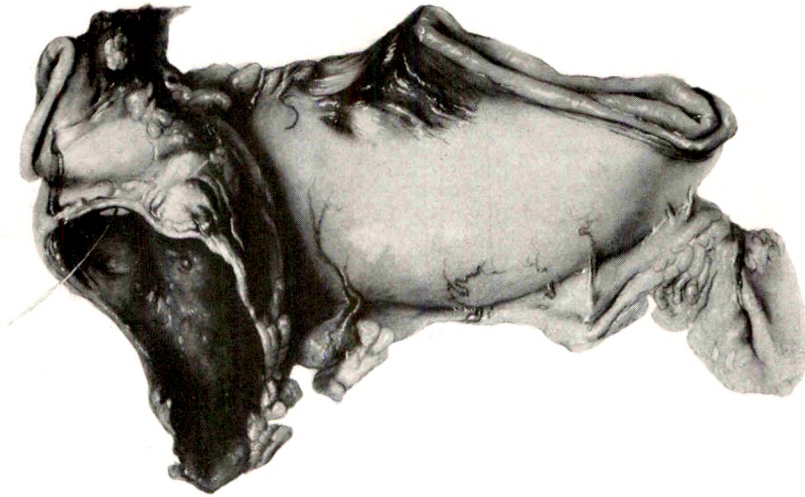


FIG. 5. Anterior view of drawing of specimen removed at operation showing where the cyst penetrated the muscle of the stomach.

lignancy. However, the smooth type of defect and the fact that it could be slightly changed by altering the position of the stomach seemed to justify a diagnosis of a non-malignant lesion.

ing the posterior wall, and perforating at the lower border of the stomach. The infiltration was so marked that permanent recovery did not seem possible, making a resection necessary.

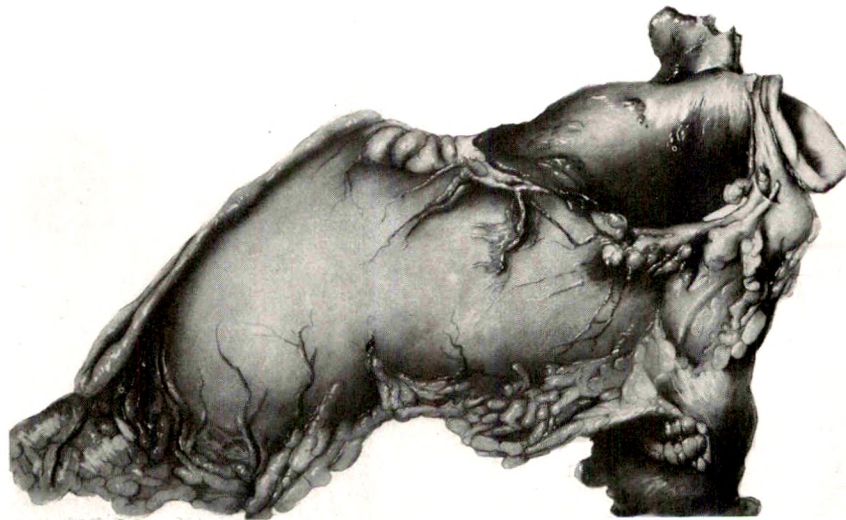


FIG. 6. Posterior view of drawing of specimen showing that the infiltration began at the lesser curvature.

A survey of the available literature does not reveal a case where there was obstruction at the pylorus due to a pancreatic cyst within the wall of the stomach.

It seems probable that at the time of the accident some damage was done to the stomach as well as to the pancreas and that

as the pancreatic fluid infiltrated the injured area of the wall of the stomach it dissected the muscular coats from the mucosa, forming a tumor within the gastric wall. This mass projected into the lumen of the stomach causing a large defect in the gastric contour and partial obstruction.

REFERENCES

1. BIRD, C. E. Tumors which may expand the curvature of the duodenum, particularly tumors and infections of the retroperitoneal lymph nodes. *Ann. Surg.*, 1929, 89, 12-29.
2. BROWN, SAMUEL. Differential diagnosis of abdominal tumors by the roentgenological method. *Radiology*, 1928, 10, 48-56.
3. FURRER, E. Ein Fall von Pylorusstenose infolge Pankreaszyste. *Schweiz. med. Wchnschr.*, 1931, 61, 162-163.
4. HULKE. Pancreatic cyst. *Lancet*, 1892, 2, 1273.
5. JUDD, E. S. MATTSON, H., and MAHORN, H. R. Pancreatic cysts; report of forty-seven cases. *Arch. Surg.*, 1931, 22, 838-849.
6. KÖRTE, WERNER. Die chirurgischen Krankheiten und die Verletzungen des Pankreas. F. Enke, Stuttgart, 1898.
7. LAZARUS, PAUL. Beitrag zur Pathologie und Therapie der Pankreaserkrankungen mit besonderer Berücksichtigung der Cysten und Steine. *Ztschr. f. klin. Med.*, 1903, 51, 95; 203; 1904, 52, 146; 381.
8. MAHORN, H. R., and MATTSON, H. The etiology and pathology of cysts of the pancreas. *Arch. Surg.*, 1931, 22, 1018-1033.
9. MARTIN, A. Ein Fall von Pankreaszyste. *Virchow's Arch. f. path. Anat.*, 1890, 120, 230-247.
10. McWHORTER, G. L. Cysts of the pancreas. *Arch. Surg.*, 1925, 11, 619-632.
11. WARNOCK, H. A. Pseudocyst of the pancreas. *Brit. M. J.*, 1929, 1, 104.



THE THERAPY OF ACTINOMYCOSIS

WITH CASE SHOWING LUMBAR SPINE INVOLVEMENT*

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THE subject of actinomycosis has been brought rather forcibly to our attention by the presence at one time of three cases in our wards, one of these having involvement of the lumbar vertebrae as a presenting symptom. There is apparently a paucity of literature dealing with the roentgenological aspects of this infection, particularly in regard to therapy.

Actinomycosis in the human is much more common than would be apparent from perusing the literature and is more widespread in distribution than is generally believed. Sanford and Voelker in 1925 made an extensive tabulation of all reported cases occurring in the United States. Their compilation shows that, although this disease is distributed widely in this country, it is especially prevalent in the upper Mississippi Valley and in the north-west portion of the country.

It is not in the province of this communication to discuss the pathology of human actinomycosis, as many publications have given adequate descriptions. It will perhaps be sufficient to enumerate the most usual sites of involvement in order of frequency as tabulated by Sanford and Voelker. According to their study, nearly 60 per cent of the cases occurred in the head and neck; slightly more than 18 per cent were abdominal; and the thoracic type was found in almost 14 per cent of the cases. However, more rarely, almost any portion of the body may be involved.

The mode of infection determines in large part the anatomical location of this disease. According to Mattson, the portals of entry in order of frequency are: first, oral cavity; second, gastrointestinal tract; third, respiratory tract; fourth, skin abrasions. Infection through the oral cavity

usually occurs as a result of chewing straw, weeds, or grain, and is responsible for the frequent involvement of the mouth and jaws. Infection through the gastrointestinal tract occurs in much the same manner, except that the infected material is ingested and is responsible for the usual abdominal involvement of cecum and appendix. Infection through the respiratory tract is usually considered to be the result of inhalation of infected material, such as the dust and chaff found around threshing machines and hay baling presses. Infection through the skin by direct inoculation through open wounds or sores is responsible for most cutaneous lesions. Some of the skin manifestations are results of blood-borne infection, according to Good. Bone involvement is thought to be uniformly the result of direct extension and metastases and is never primary. The usual sites of bone involvement are mandible, ribs, pelvis, sternum, and vertebrae. Occasionally other bones may be affected. The lumbar vertebrae are rarely involved, although this involvement constitutes the presenting symptom in one of the cases reported in this communication.

The presenting symptoms of actinomycosis naturally vary with the anatomical location. In cervicofacial involvement, the most prominent feature is a hard, indurated swelling of the affected region, which, when adjacent to the mandible, causes impaired function. In the later stages, there is apt to be a breaking down of the induration with sinus tract formation.

Abdominal actinomycosis is rarely, if ever, correctly diagnosed at the initial examination. The presenting symptoms are indistinguishable from either acute or chronic appendicitis, and the patients are

* From the Department of Roentgenology, University of Virginia Hospital, University, Virginia. Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

operated upon under these diagnoses. Even at operation, actinomycosis of the appendix is usually not differentiated from the usual forms of appendicitis and appendicial abscess, since the gross pathology is so similar. Usually only the clinical course following operation leads to the correct diagnosis. According to Good, the postoperative course is somewhat as follows: The convalescence is essentially that of the usual case of appendicitis, with good wound healing in a high percentage of cases. Several weeks after operation, there is an exacerbation of symptoms with toxic manifestations and tenderness either in the region of the incision or in the flank. By this time, an abscess has formed, which is usually incised and drained. A sinus tract then forms, which drains for an indefinite period. The chronically draining appendicial sinus should then lead the surgeon to rule out actinomycosis, for this is the most frequent cause of such sinuses. Repeated microscopic examinations of the material from the sinuses may be necessary before the fungus is found.

The symptoms of intrathoracic actinomycosis, according to Good, may simulate those of several other diseases: first, simple catarrhal or mucous bronchitis, when the sputum is mucoid, or bronchiectasis when the sputum is fetid; second, bronchopneumonia; third, tuberculosis; fourth, lung abscess. Roentgen examination of these cases shows no definitely pathognomonic features. Kirklin and Hefke have reviewed a series of 14 cases in which the roentgenological features are described, and they state that there is only one materially helpful diagnostic point when present, and that is rib destruction with apparent lung abscess. Chronic lung abscess would not lead to such involvement.

Actinomycotic lesions of the skin, according to Andrews, are rather characteristic, being local, dusky red swellings, deep, fluctuating nodules, and sinuses exuding a purulent discharge. This author states that primary actinomycosis of the skin is a rare disease.

The positive diagnosis of actinomycosis in the various locations depends upon the identification of the fungus microscopically. According to Figi and Cutts, actinomycosis must be considered as a diagnostic possibility with regard to indeterminate tumor, chronic infection, or persistent sinus, even if the patient is young. Any atypical chronic lung infection, any hard indurated swelling in the cervicofacial region, and particularly, any chronically draining abdominal sinus should at least arouse suspicion as to the possibility of actinomycosis. In all such cases, smears should be made from sputum and pus in an attempt to identify the fungus. Repeated examinations may be necessary before the organism is found. Tissue sections are sometimes of value, although negative reports do not exclude the possibility of the disease.

The treatment of actinomycosis has varied greatly from time to time. The original treatment was surgery alone, which gave rather unsatisfactory results. Later, iodides were administered internally either alone or in conjunction with surgery, and there was an improvement in results. According to Bérard, a commission appointed by the French Government in 1893 administered iodine experimentally to animals affected with actinomycosis. Out of 185 animals treated, 131 were reported as cured. Roentgen irradiation was successfully used by Harsha in 1904 in conjunction with incision and iodides by mouth. Since that time, numerous authors have presented their results, most of them ascribing the good results chiefly to irradiation. According to Desjardins, the clinical evidence of proved cases reported in the literature seems to indicate that the chief factor in these cases was irradiation, and not surgery and iodides. This author states that in his opinion neither surgery nor iodides are contraindicated but are distinctly useful in conjunction with irradiation. He also stresses the importance of early diagnosis so that treatment may be instituted before massive involvement has taken place. In our clinic, combinations of surgery and iodides with

roentgen irradiation have been used to advantage. Surgical intervention should be confined to the evacuation of pus. Massive doses of iodides are administered by mouth,

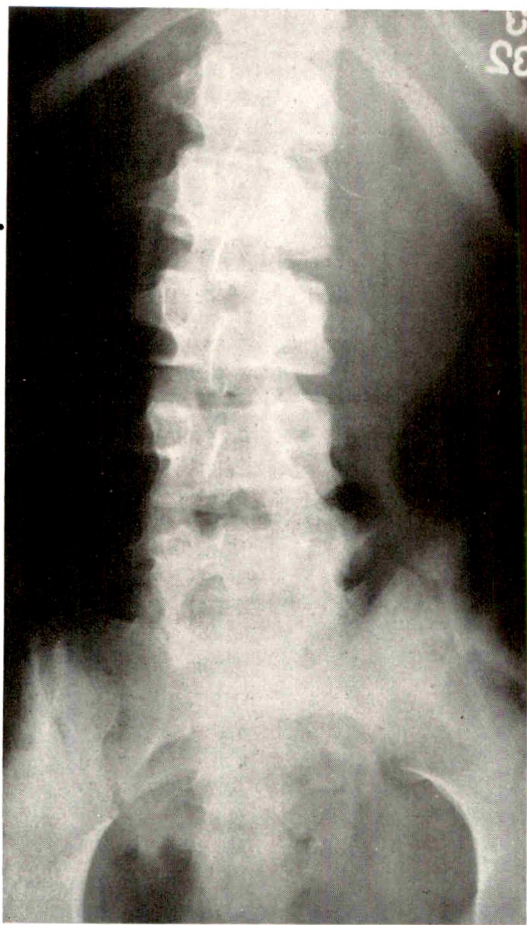


FIG. 1. Case 1. Showing invasion of lumbar vertebrae by actinomycosis.

the dosage varying with the size of the patient, but ranging up to 250 minims of potassium iodide three times per day. One child ten years of age, with cervicofacial involvement, received 160 minims thrice daily. With combined irradiation and iodide therapy, a cure was obtained. It has been our custom to administer a saturated solution of potassium iodide, giving 10 to 20 minims by mouth three times daily, and increasing the dosage quite gradually until the limit of tolerance is reached. More re-

cently, we have been using tincture of iodine in milk, following the method of treatment outlined by Chitty in 1926. This author reports cures in four successive cases by the use of 5 to 10 minims of tincture of iodine, three times daily, freshly added to one-half cup of milk. According to Chitty, iodine in milk forms a truly colloidal solution, which might possibly be more effectual than the usual method of iodide administration, but our experience with this method is too recent and too limited to warrant any opinion regarding this form of therapy. These methods of iodide therapy are combined with roentgen irradiation. The voltage varies from 132 to 200 peak kilovolts, and the filtration varies from 4 mm. of aluminum in the relatively superficial to 0.5 mm. of copper plus 1 mm. of aluminum in the abdominal cases, each depending upon the location of the lesion. A sufficient number of portals is used to secure a depth dose equivalent to one-half erythema at the site of the lesion, the number of roentgens depending upon the quality of the radiation. This course of treatments is repeated every three weeks as long as there is indication, the location of the portals being varied to save the skin.

In our series of cases, there is one which has particularly interested us on account of the involvement of the lumbar vertebrae, which, judging from the cases reported in the literature, is quite rare. Briefly summarized, the case histories are as follows:

CASE 1. Female, colored, aged fourteen, admitted to the Hospital complaining of an intermittently draining sinus in the right lower quadrant, present since an appendectomy three years previously. One year prior to admission, there was a mass which ruptured spontaneously over the anterior aspect of the left ilium. A second draining sinus persisted at this point. Six months prior to admission, the patient began to suffer with "stiffness in her right hip."

Physical examination on admission was negative except for two draining sinuses, 45° flexion of the right thigh, and extreme emaciation.

Roentgen examination (Figs. 1 and 2) of the pelvis and lumbar spine showed irregular,

fuzzy, new bone formation over the bodies of the lumbar vertebrae and the anterior aspect of the sacrum. In the bodies of the lumbar vertebrae, there were small, irregular areas of bone destruction. The intervertebral discs showed no narrowing. The peculiar appearance of the spine, together with the draining sinuses, led us to suspect actinomycosis, which was later proved microscopically.

The patient has received tincture of iodine in milk and roentgen irradiation since May 26, 1932, eight courses of 200 kv. radiation having been given. Her general condition at this time (September 10, 1932) shows little change, but there has been a distinct decrease in the amount of drainage from the sinus.

CASE II. Female, colored, aged sixteen, admitted to the Hospital complaining of a "sore on her right side" of one month's duration.

Physical examination was essentially negative except for two draining sinuses on the right posterior axillary line at the level of the first lumbar vertebra, with a definite mass beneath the sinuses.

Roentgen examination of the chest was negative. An opaque enema showed a torsion deformity of the cecum without evidence of infiltration. Bilateral pyelograms showed a moderate degree of dilatation of the right renal pelvis and calyces.

The sinus tracts were explored surgically on several occasions and were seen to extend both to the right renal region and toward the cecum, but it was impossible to demonstrate definite primary involvement in either region. Smears were positive for actinomyces on several occasions.

The patient received massive doses of potassium iodide by mouth and sodium iodide intravenously, together with 200 kv. roentgen irradiation, keeping the lesion at one-half erythema dose level for a period of six weeks. The patient's condition steadily grew worse, and she died seven weeks after institution of therapy. Although strenuous efforts were made to obtain an autopsy, this was refused.

CASE III. Male, white, aged fifty-one, farmer, was operated upon in November, 1928, for ruptured gangrenous appendix, following which a sinus tract developed. Some time after returning home, a hard mass developed to the left of the abdominal incision, which had continued to drain. In March, 1929, the patient was again admitted, presenting the mass and the draining

sinus. An incision was made in the mass, and the sinus tract was opened up. Smears from the material removed were positive for actinomyces. Massive doses of potassium iodide were given in conjunction with 135 kv. roentgen irradiation.



FIG. 2. Case 1. Lateral view, showing normal joint spaces, fuzzy new bone formation, and small areas of bone destruction.

tion, two courses being given. No improvement was noted. The patient did not return for further treatment and died about three months after institution of therapy.

CASE IV. Male, white, aged forty-seven, admitted to the Hospital April 1, 1928, one month after an acute illness. At the onset, the patient had a high temperature and chills for several days, with a pain in his right chest. On the day of admission, he coughed and expectorated large quantities of purulent material.

Physical examination revealed signs of right-

sided empyema. Laboratory studies revealed severe diabetes.

Roentgen examination showed encapsulated fluid in the posterior portion of the right thoracic cavity.

Thoracostomy was done, and 1000 c.c. of greenish yellow, purulent material was evacuated. A second drainage was done a month following this, soon after which actinomyces were discovered. About five months following this, swellings were noted over the angle of the left jaw and over the left scapula. Actinomyces were found in the material from these lesions.

Massive doses of iodides were started at this time, and roentgen irradiation was initiated two months following this. The patient received four courses of roentgen therapy and continuous iodide medication. He was discharged fourteen months after admission, considerably improved. He was able to resume part time work on the farm. Fifteen months following this, he was admitted for diabetic gangrene, his chest being in a quiescent stage. He was admitted twice within the next one or two years for control of the diabetes. In April, 1932, he was admitted for further treatment of the chest. In the seven months preceding this, the sinus tract in the lower right chest started draining continuously, having ceased draining three months after his first discharge from the Hospital. Since April, 1932, he has received six courses of roentgen irradiation with slight improvement.

CASE V. Male, colored, aged nine, admitted to the Hospital complaining of swelling of the right jaw of six weeks' duration. This was associated with some pain and inability to open the mouth widely. There was some swelling in the right cervical region just below the angle of the jaw.

Roentgen examination showed well-defined new bone formation about the angle of the right jaw, without bone destruction.

Incision of the mass at this time showed only inflammatory tissue. Operation for drainage was done a month later and again a month following this, when an incision was also made over the cheek and the process found to extend up to the region of the frontal sinus. At this time, actinomyces were found.

The patient was put on massive doses of iodides by mouth and was given four courses of roentgen therapy. He was last seen six months after admission and was practically well. We have since heard that he is entirely well.

CASE VI. Male, white, aged ten, admitted to the Hospital complaining of inability to open the mouth for the past four weeks. There was a definite hard mass at the angle of the left jaw, which was apparently fixed to the bone.

Roentgen examination was negative.

Incision into the mass was done with the evacuation of some pus which contained sulphur granules. The microscopic examination confirmed the diagnosis of actinomycosis.

The patient was started on massive doses of iodide by mouth, and roentgen therapy.

When the patient returned one month later, an inflammatory mass was excised. He was continued on iodide by mouth and given five courses of roentgen therapy. The patient was last seen December, 1930, four months after the first admission, and was much improved. We have since learned that this patient is entirely well.

CASE VII. Female, white, aged twelve, admitted to the Hospital complaining of a swelling over the lower left jaw of six months' duration.

Roentgen examination showed some new bone formation about the angle of the mandible, with irregular areas of bone destruction.

Incision with evacuation of pus was done along with curettage of the bone. Sulphur granules were found, and these showed actinomyces microscopically. The operative wound healed nicely, and the patient left the Hospital in eight days. The patient was last seen in 1930, ten years after operation, and has had no recurrence of her trouble. Neither iodides nor roentgen therapy was used in this case.

CASE VIII. Male, white, aged forty-one, admitted to the Hospital complaining of inability to open the mouth, except partially, for six months previous to admission. There was a definite mass at the angle of the left jaw. Incision was made into the mass, and sulphur granules were found, which revealed organisms of actinomycosis on microscopic examination.

The patient was put on iodides by mouth, with the dose to be increased to 200 minims, three times daily. She was readmitted one month later, when another fluctuating mass was incised and drained, with curettage of the mandible. Iodides by mouth were continued for several weeks. The patient was apparently well within a few months, and when seen recently, eight years after operation, was entirely well.

COMMENT

From a study of the literature and observation of our limited series of cases, it is apparent that the response to therapy directed against actinomycosis varies greatly with the anatomical location. Cervicofacial involvement almost invariably responds well to surgical curettage, iodides, and roentgen irradiation, and frequently even to surgery alone, where the disease is well localized, as is shown in one of our cases. Where there is more extensive involvement, iodides and radiation therapy should be used as adjuncts to surgery, since complete surgical extirpation of the diseased tissues would be impossible on account of the complex cervicofacial anatomy and facial disfigurement. The cases of actinomycosis with thoracic and abdominal involvement present quite a different problem. Surgery in these cases plays a minor rôle and should be used only to evacuate pus and to establish drainage. Massive doses of iodides and roentgen irradiation are the principal therapeutic agencies in such cases. The results in these patients are not brilliant, but sufficient improvement has been noted to warrant the continuation of this method of treatment until the advent of a more satisfactory therapeutic regimen. Since thoracic

and abdominal cases are usually not diagnosed until there is extensive involvement, it is apparent that one cannot hope for complete surgical removal of all of the diseased tissue. This being true, too radical surgery with dissection of all sinus tracts would tend to spread the process rather than to effect a cure. The best results in this type of case seem to be obtained by keeping these patients continuously on iodides by mouth up to the limit of tolerance, combined with roentgen irradiation, and by using surgery only for the evacuation of collections of pus.

SUMMARY

A case of lumbar spine involvement secondary to abdominal actinomycosis is presented.

Cervicofacial lesions usually respond readily to surgery, massive doses of iodides by mouth, and roentgen irradiation.

Thoracic and abdominal lesions are much less amenable to any form of treatment, but many are benefited to a greater or less degree by continuous massive doses of iodides up to the limit of tolerance, combined with roentgen irradiation. In these cases, surgery should be used only to establish drainage for collections of pus.

REFERENCES

1. ABBOTT, D. P. Primary actinomycosis of kidney. *J. Am. M. Ass.*, 1924, 82, 1414-1415.
2. ALBERT, HENRY, HARDY, J. B., and HARRISON, J. W. Actinomycosis of the abdominal wall. *J. Am. M. Ass.*, 1923, 81, 653-654.
3. ANDREWS, GEORGE C. Diseases of the Skin. W. B. Saunders, Philadelphia, 1930, p. 589.
4. BARLOW, R. A. Actinomycosis of the tongue. *Ann. Surg.*, 1925, 81, 881.
5. BÉRARD, D. G. The treatment of actinomycosis with potassium iodide. *Internat. Clin.*, 1921, 3, 107-110.
6. BRICKNER, W. M. Pelvic actinomycosis; study of five consecutive cases successfully treated by operation. *Ann. Surg.*, 1925, 81, 343-367.
7. BRUCE, HERBERT A. Actinomycosis. *Ann. Surg.*, 1923, 78, 294-299.
8. CHITTY, HUBERT. Actinomycosis successfully treated by iodine in milk. *Brit. M. J.*, 1926, 1, 418-419.
9. DESJARDINS, ARTHUR U. Radiotherapy in actinomycosis. *Radiology*, 1928, 11, 321-332.
10. FIGI, F. A., and CUTTS, R. E. Actinomycosis in childhood. *Am. J. Dis. Child.*, 1931, 42, 279-290.
11. GOOD, LOUIS P. Actinomycosis of the thorax. *Arch. Surg.*, 1930, 21, 786-800.
12. GOOD, LOUIS P. Actinomycosis of the abdomen. *Arch. Surg.*, 1931, 22, 307-313.
13. HARSHA, WILLIAM M. Actinomycosis of the jaw. *Ann. Surg.*, 1904, 39, 459-460.
14. HEYERDAHL, S. A. Actinomycosis treated with radium. *J. Am. M. Ass.*, 1919, 73, 1928-1929.
15. JENSEN, V. W., and SCHERY, C. W. Actinomycosis treated with methylene blue and roentgen ray. *J. Am. M. Ass.*, 1920, 75, 1470-1473.
16. MATTSON, W. W. Human actinomycosis, with special reference to source and mode of infection. *Surg., Gynec. & Obst.*, 1922, 34, 482-494.

17. McWILLIAMS, C. A. Actinomycosis of phalanx of finger. *Ann. Surg.*, 1917, 66, 117-118.
18. NAUSSAC, JOSEPH. Pathology, symptomatology and differential diagnosis of pulmonary actinomycosis. *Internat. Clin.*, 1921, 3, 1-18.
19. NEW, G. B., and FIGI, F. A. Actinomycosis of the head and neck. *Surg., Gynec. & Obst.*, 1923, 37, 617-625.
20. PARKER, C. A. Actinomycosis and blastomycosis of the spine. *J. Bone & Joint Surg.*, 1923, 5, 759-777.
21. SANFORD, A. H. Distribution of actinomycosis in the United States. *J. Am. M. Ass.*, 1923, 81, 655-659.
22. SANFORD, A. H., and VOELKER, M. Actinomycosis in the United States. *Arch. Surg.*, 1925, 11, 809-841.
23. SCHUGT, P. Actinomycotic parametritis. *Monatsschr. f. Geburtsh. u. Gynäk.*, 1925, 69, 192-201. Abs. in *J. Am. M. Ass.*, 1925, 85, 157.
24. SIMPSON, W. M., and MCINTOSH, C. A. Actinomycosis of the vertebrae (actinomycotic Pott's disease). *Arch. Surg.*, 1927, 14, 1166-1186.
25. WATERMAN, A. H., and FITZPATRICK, G. Cutaneous actinomycosis recurring after pregnancy. *Ann. Clin. Med.*, 1925, 3, 697-705.
26. WEISER, A. Diagnosis of actinomycosis of the bladder. *Ztschr. f. urol. Chir.*, 1925, 18, 211-217. Abs. in *J. Am. M. Ass.*, 1925, 85, 1342.
27. WOHL, M. G. Fungous diseases of man in the State of Nebraska; sporotrichosis, blastomycosis, actinomycosis. *J. Am. M. Ass.*, 1923, 81, 647-653.



THE DETECTION AND ESTIMATION OF RADIUM IN LIVING PERSONS

IV. THE RETENTION OF SOLUBLE RADIUM SALTS ADMINISTERED INTRAVENOUSLY

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THE administration of soluble radium salts intravenously was undertaken in Elgin State Hospital in March, 1931, with a selected group of patients, classified for the most part as dementia praecox cases. Radium chloride in 10 microgram doses dissolved in isotonic sodium chloride solution, having a volume of 2 c.c., and carefully standardized, was injected at intervals of a few days to a week over periods which ranged from two months to six months. The lowest amount administered to any one patient was 70 micrograms, and the highest, 450 micrograms. During the last week in December the radioactivity of these patients was measured by both the gamma-ray method for testing persons for radioactivity and the expired-air method. In June, 1932, six months later, another series of tests for radioactivity was made on the same patients, no radium having been administered to the patients between the first and second measurements of radioactivity. The results of the radioactive measurements thus constitute a contribution to our knowledge of the retention of radium in the human body. In addition, a summary of clinical observations has been incorporated.

Recently Barker and Schlundt,¹ with the cooperation of a small group of medical men who have administered radium internally for several years, measured the radium retained by 10 patients to whom radium chloride had been administered orally and intravenously over periods ranging from

two years to four years, and in amounts totalling from 80 micrograms to 1,455 micrograms. They also refer to earlier investigations on the elimination of radium given internally. In 5 of the patients the tests for radioactivity were negative, but one of the subjects retained between 20 to 30 micrograms out of 890 administered, one and two-thirds years after the last time radium chloride was administered intravenously. Through the courtesy of Mr. H. M. Armstrong of the Radium Extension Service we were given the opportunity of testing again one of the radioactive patients, Case IX, at this time, when fully two years had passed since radium had been administered. In 1930, the radium retained by this patient was found to be between 10 to 18 micrograms, and to our surprise this patient still retains nearly the same amount today. This anomalous result stands out in contrast to the findings upon second measurement of the patients in Elgin, each of whom shows a marked loss in radium during the lapse of six months.

EXPERIMENTAL PART

To determine the total amount of radium in the body it is necessary to make two sets of measurements: (1) the gamma-ray activity of the subject, and (2) the quantity of radon (radium emanation) continuously expired by the patient. The sum of the two measurements gives the total radium present.²

The basis for this method is readily understood when one bears in mind that the total radium in the body is made up of two parts: (1) the fraction which holds its offspring, radon and its transformation products, Ra A, B, and C, and (2) the part which continuously gives off the radon produced. The gamma rays from radium are emitted entirely by Ra C, whose amount depends solely upon that part of the radon produced and which is retained in the system. The radon which is exhaled by the patient does not contribute to the gamma-ray activity. By measuring the quantity of radon in the expired air, that part of the radium which escapes detection by the gamma-ray method is determined.

Gamma-Ray Measurements. The gamma-ray measurements were made with a new Wulf-Hess quartz-fiber (bifilar) instrument,³ whose natural drift amounted to only one small subdivision of the scale of one of the fibers in 35 to 45 minutes. We followed very closely the method described by Schlundt, Barker and Flinn. The electrostatic capacity of the electrometer supplied by the makers is 1.04 cm., and a fall of one subdivision of one of the fibers represents a drop in potential of 3.44 volts for that part of the scale over which readings were always made. The extremely small natural ionization current of the instrument may be calculated by substituting values in the formula,

$$i = \frac{CV}{300t}$$

where i stands for the ionization current expressed in electrostatic units, which may be converted into amperes by dividing by 3×10^9 ; C is the electrostatic capacity, 1.04; V , the potential drop in volts, observed during the time, t , expressed in seconds; 300 being the factor for converting volts into electrostatic units. For a natural drift of one subdivision in 40 minutes, the value of i comes out 4.97×10^{-6} e.s.u., or 1.66×10^{-15} amperes. The number of ion pairs produced per second in the chamber of the electroscope is given by dividing the

current, 4.97×10^{-6} e.s.u. by the unit charge, 4.77×10^{-10} , which gives about 10,000. Since the actual volume of the chamber of the electroscope is approximately 1000 c.c., it follows that the natural drift of the instrument corresponds to a production of 10 ions per c.c. per second.

Next suppose we observe the drift of the electroscope when a radioactive patient is sitting near it and we find that the fiber drifts one division in 25 minutes. Substituting for t in the above formula, and subtracting the natural ionization current, we find that the increase in drift corresponds to an ionization current of 2.98×10^{-6} e.s.u., or the production of 6.3 pairs of ions per c.c. per second by the penetrating radiation from the subject under test. This form of expressing activities has one advantage: activities measured with other electrometers similar in type but differing in capacity and voltage scale are directly comparable when expressed as ionization currents.

Useful as this method of expressing activities often is, it however falls short for one of our purposes, in not stating the actual quantity of radium present in the person under test. In computing the number of micrograms of radium responsible for the gamma-ray activity of the patients we divided the observed net drift per second by 0.000180 (180×10^{-6}). This calibration constant, 180×10^{-6} , for the Wulf-Hess instrument, used for making all the gamma-ray measurements, represents the net drift of each fiber in divisions per second produced by each microgram of radium present in the system.

This value for the calibration constant of our Wulf-Hess electrometer is based upon an experimental calibration of a duplicate instrument by Mr. F. L. Knowles of the U. S. Public Health Service.⁴ He states:

"In order to determine the sensitivity of the Wulf-Hess electroscope under known and easily reproducible conditions (so that the readings obtained with this electroscope could be compared with those obtained with other electro-

scopes), a 10 mg. standard of radium enclosed in a cylinder of lead, having an outside diameter of 27 mm. and an inside diameter of 20 mm., was placed 65 cm. from the center of the electroscope, and the net rate of fall of the fibers of the Wulf-Hess electroscope determined under these conditions. It was found to be 0.331 divisions per second."

We placed a radium standard of 5.27 mg., 65 cm. from the center of our instrument and found the net drift to be 0.207 divisions per second. Our radium standard would produce a net drift in the electroscope calibrated by Knowles of 0.174 divisions per second. Hence, our instrument is a little more sensitive, the ratio being 1.19.

Since Knowles found that each microgram of radium in a human cadaver produced a net drift of 151×10^{-6} divisions per second in the Wulf-Hess electroscope used in his work, it follows that one microgram of radium will produce a net drift of $151 \times 10^{-6} \times 1.19$ or 180×10^{-6} divisions per second, and this is the value we have used in converting observed net drifts into micrograms of radium by the gamma-ray method of estimation.

Knowles determined the calibration constant of his instrument by measuring the net drift produced by the gamma radiation from a cadaver implanted with a number of radon seeds of known gamma-ray activity distributed over the body proportionately to the bone mass. An extended series of readings for three different amounts of radon averaged a net drift of 151×10^{-6} divisions per second per microgram of radium. Two other methods of calibrating gamma-ray electroscopes in terms of net drift per microgram of radium are described by Schlundt, Barker, and Flinn² and by Schlundt and Failla.⁶

The U. S. Public Health report gives still another convenient method of calibrating a gamma-ray electroscope:

"The distance from the electroscope at which an amount of radium equal to the amount of radium distributed in the body of the

cadaver must be placed in order to produce the same net drift of the fiber, was determined by placing an arbitrary amount, 174.2 micrograms of radon at distances of 37, 36 and 34 cm. from the electroscope. The effective distance determined in this way was found to be 37.4 cm."

One thousand one hundred and twenty (1,120) micrograms of radium placed at a distance of 37.4 cm. from the center of our electroscope produced a net drift of 0.194 divisions per second, or the net drift per microgram of radium is 173×10^{-6} divisions per second.

Radon in Expired Air. The first series of determinations of the amount of radon in the expired air of the patients were made with two Lind electroscopes, the ionization chambers of which had a volume of 2,700 c.c. These instruments were loaned to us by Dr. Frederick B. Flinn of Columbia University. For the second series of measurements, the Lind electroscopes used were loaned to us by the U. S. Public Health Service. These electroscopes were used in preference to our own instruments on account of their low natural drift, which was generally less than 0.008 divisions per second and at times ran as low as 0.004 divisions per second.

Each electroscope was calibrated by us in terms of radium units. Readings of natural drifts were taken before and after each test, and always over the same part of the scale and over approximately the same number of divisions of the scale. With "expired air" in the chamber at least two sets of readings were always made, the first one ten minutes after the introduction of the exhaled air and then a second one after a noted interval of about half an hour. From these readings the maximum value was deduced by extrapolation on the ionization curve for radon. About once a day the extrapolated value was checked by making a set of readings at the time of maximum, three hours after introduction of the exhaled air. Thorium emanation was not detected in the expired air.

The expired-air tests were made by hav-

ing the subject blow through a drying train and an ionization chamber connected in series for a time, three to four minutes—sufficiently long to make sure that practically all the air originally in the chamber had been replaced by “expired air.” Several patients could not be induced to blow normally and a few refused to blow at all. This accounts for question marks after a few values and for blanks in the table.

To calculate the quantity of radium that must be present to generate the radon that is continually being exhaled it is necessary, of course, to measure the volume of the air expired in normal breathing, in a given interval of time. This quantity was not measured for each patient. Instead, we have arbitrarily used the same factor for all patients. We have assumed an average value of one liter of air being expired in 8 seconds or 2.7 liters in 21.6 seconds. The first objective is to find the quantity of radon expired per second. This figure is obtained by multiplying the observed net drift of the electroscope by its calibration constant and dividing by 21.6. Then dividing by 2.09×10^{-6} , the rate at which radon is produced from radium, gives the number of grams of radium in the body producing the radon in the exhaled air.

Since the variations in the amounts of air exhaled by different persons over the same period of time are by no means small, it follows that the radium values reported for the expired-air determinations are only roughly approximate, and we must rely on averages in any discussion of these results.

We feel justified in assuming that the individual patient performed the blowing of air through the ionization chamber in practically the same way the second time he was tested as he did the first. The two radium values reported under expired air for the same patient thus appear to be quite comparable. Hence, the percentage decreases in radium values observed between the first and second series of tests do not involve the element of error that may exist in the actual number of micrograms of radium reported.

Measurements were made on one of the student nurses who had not received radium treatment. This control subject is the last one in the table.

The results of our measurements are summarized in Table 1. The second column gives the total quantity of radium administered to the patient expressed in micrograms. A dosage of 150 micrograms represents 15 treatments of 10 micrograms each administered weekly. In the third column is recorded the time that had elapsed between the last injection of radium and the date on which the first series of measurements for radioactivity were made, the closing week of December, 1931. The next column, four, gives the quantity of radium measured by the gamma-ray electrometer. This is the amount of radium from which the radon and its disintegration products are retained in the system. Column five gives the radium which produced the radon that is continually exhaled. The next column, six, gives the total radium retained by the patient; and the next column, seven, gives the percentage of radium still present in the system. In the second section of the table we have recorded in four columns the results of our second series of measurements made six months later.

Summary and Discussion. Of the 25 patients first measured, complete gamma-ray and expired-air tests were obtained for 13 in the second series of measurements. Omitting patient *N* from the first series, the 12 patients had received 2,190 micrograms of radium of which 93.6 micrograms were retained, or 4.3 per cent. Six months later, these 12 patients and patient *N* to whom a total of 2,550 micrograms of radium had been administered retained only 49.4 micrograms or 1.9 per cent. During the interval of nearly six months between the first and second series of measurements these patients eliminated 55 per cent of the radium present at the time of the first tests, or they lost radium at the rate of about 13 per cent per month as deduced by substituting in the simple exponential formula: $N = N_0 e^{-rt}$, where N is

45; N_0 , 100; and t , 6 months; then, solving for r . The applications of this formula hold when we assume that the amount of radium eliminated at any time is proportional to the amount present at the time. The average percentage elimination of radium during the interval of six months between the first and second series of measurements is not changed materially by comparing separately instead of the totals, either the gamma-ray values or the expired-air values. The rate of elimination found adds to the findings of other investigators. They confirm one of the results of Seil, Viol, and Gordon⁵ who studied the elimination of soluble radium salts and report that after the rapid elimination of radium during the first week after administration, they found the amount eliminated to be less than 1 per cent per day. Schlundt and Failla,⁶

on the other hand, by analysis of excreta found that two dial painters who had contracted poisoning twelve years before, eliminated the radium at the rate of only 0.1 per cent per month. Evidently then, as time goes on, the radium remaining in the system becomes more firmly fixed.

At an early stage of our measurements we became impressed with the relatively high proportion of radon continually exhaled by the patients. The amount of radium which retains radon and its disintegration products, Ra A, Ra B, Ra C, was found to be less than one-seventh of the total present at the time the first series of measurements were made, and approximately one-sixth of the total present six months later. Adding up the gamma-ray values and expired-air values for 12 of the most radioactive dial painters free from meso-

TABLE I
RADIIUM RETENTION OF PATIENTS

December, 1931

June, 1932

Patient	$\mu\text{gm. Ra}$ Given	1st In- terval	$\mu\text{gm. Ra}$ Gamma Ray	$\mu\text{gm. Ra}$ Expired Air	Total Ra	Ra Retained per cent	$\mu\text{gm. Ra}$ Gamma Ray	$\mu\text{gm. Ra}$ Expired Air	Total Ra $\mu\text{gm.}$	Ra Retained per cent
A	150	6 mo.	1.0	7.2	8.2	5.5	0.9	2.5	3.4	2.3
B	150	6	0.6	5.4	6.0	4.0	0.3	2.8	3.1	2.2
C	150	6	0.3	3.4	3.7	2.5	0.17	1.4	1.6	1.1
D	150	6	1.4	12.5	13.9	9.6	—	—	—	—
E	160	6	1.3	12.5	13.8	8.8	1.4	4.1	5.5	3.5
F	160	6	0.9	3.7	4.6	2.9	0.7	—	—	—
G	160	6	0.7	2.9	3.6	2.3	0.3	0.0	0.3	0.2
H	160	6	0.4	3.4	3.8	2.4	0.08	1.8	1.9	1.2
I	180	6	0.8	5.9	6.7	3.7	0.09	1.8	1.9	1.1
J	200	6	0.3	5.9	6.2	3.1	0.07	4.1	4.2	2.1
K	200	6	0.5	—	—	—	—	—	—	—
L	260	4	2.3	12.0	14.3	5.5	1.8	3.3	5.1	2.1
M	380	4	1.0	—	—	—	1.3	—	—	—
N	360	6	1.1	1.8?	2.9?	—	0.9	5.7	6.6	1.8
O	260	23 d.	1.2	6.4	7.6	2.9	0.7	2.4	3.1	1.2
P	250	30	1.1	5.8	6.9	2.8	0.9	4.2	5.1	2.2
Q	450	20	1.6	16.1	17.7	4.0	1.3	—	—	—
R	410	13	1.1	—	—	—	—	—	—	—
S	70	60	0.5	—	—	—	—	—	—	—
T	110	30	0.75	8.3	9.0	8.2	0.5	4.8	5.3	4.9
U	90	30	0.5	—	—	—	0.6	—	—	—
V	100	30	0.3	6.2	6.5	6.5	—	—	—	—
W	90	30	1.1	8.6	9.7	10.8	—	—	—	—
X	90	30	0.3	3.9	4.2	4.7	—	—	—	—
Y.	—	—	0.03	.00	0.03	—	0.01	.00	—	—

thorium, measured by Knowles of the U. S. Public Health Service, we find that the radon exhaled falls slightly short of one-half of the total produced by the radium present in the subjects. Likewise, the percentage of radon expired by radioactive patients measured by Barker and Schlundt falls slightly below half of the total.

The high emanating power of the radium present in the Elgin patients indicates that the radium had not yet passed into the crystalline state of aggregation.⁷ Although the solubility of radium sulphate is fully 100 times less than that of barium sulphate, the volume of the blood can carry in solution a quantity five times the doses (10 μ gm.) regularly administered to the Elgin patients. Probably then the radium ions exist in the system in combination with colloidal substances analogous to radium adsorbed on precipitated ferric hydroxide, which is characterized by its high emanating power.^{8,9} This result of our investigation deserves further study.

As a consequence of the high emanating condition of the radium, its alpha radiation, the active therapeutic agent of radium present in the system, is diminished to about 40 per cent of the number of alpha particles which would radiate tissue if all the radon generated were retained. The gamma-ray values of the patients serve as an index of the penetrating radiations, the beta and gamma rays, whose source is mainly Ra C.

CLINICAL DATA

Before viewing the clinical aspect of the 32 psychiatric patients who were treated at the Elgin State Hospital from March to December, 1931, with intravenous injections of radium chloride, the following points should be clearly understood.

Previous researches on the rate, manner, and completeness of the elimination of radium from the body convinced us of the harmlessness of our dosages. We therefore were certain not to injure the health of the patients.

We used only a reliably standardized

solution of radium chloride, thus avoiding the hazards which are inherent in uncontrolled products. This safeguard was also necessary in view of the fact that unfavorable comments have accompanied the application of many commercial radium products.

The biologic action depends on the degree of ionization which in turn is directly proportional to the quantity of alpha radiation. The penetrating range of alpha rays is exceedingly short compared with gamma rays, and the maximum exploitation, therefore, is assured if the source of alpha rays—in this case, the pure radium salt—comes in the closest possible contact with all tissues of the body. For that reason, the injections were given intravenously.

Radium and its derivatives have been used by many investigators; some reports are enthusiastic, some dispute its value. More or less convincing claims have been advanced that it stimulates hematopoiesis, metabolism, excretion of nitrogen in the urine and mobilization of sulphur; that it acts in a way similar to arsenic as a general tonic; that it combats toxemias by increasing oxidation, lessens the coagulation time of the blood and intensifies the glandular activity. If these claims are anywhere near the truth, radioactivity in the living body might result in some benefit in certain psychoses.

Beyond a large vocabulary and an imposing array of speculations about "mental mechanisms," we know very little about the causation of a large number of mental disorders. But just because our crude pathological anatomical methods fail to reveal gross alterations in the structure of the brain, we could hardly assert that there can be no molecular or atomic alteration of the brain structure. Dissociation, ionization, hydration, dehydration, etc.,—who knows much about the rôle they play in the living nerve cell? We admit that in using radium as an alterator of molecular structure, for instance, or as a source of radiating energy in general, we have a vague idea that it

TABLE II
AMOUNT OF TREATMENT AND IMPROVEMENT*

Patient	Psychiatric Classification	Amount of Treatment	Improvement
Evangeline P.	D. P. Paranoid	140 μ gm.	2-plus
(E) Elizabeth J.	Invol. Melancholia	160	2-plus
(M) Anna M.	D. P. Paranoid	360	3-plus (At home)
(S) Lina P.	Invol. Melancholia	70	3-plus (At home)
(V) Lawrence P.	D. P. Catatonic	100	3-plus (At home)
(T) Dorothy D.	D. P. Hebephrenic	110	3-plus (At home)
(U) Allan W.	D. P. Hebephrenic	90	4-plus (At home)
(W) Charles W.	D. P. Unspecified	90	4-plus (At home)
Rose D.	Manic. Dep., Dep.	200	4-plus (At home)
Edith C.	Undiagnosed Psych.	260	4-plus (At home)
Sadie S.	Invol. Melancholia	150	4-plus (At home)

Total number of improvements and recoveries, 11

(In the above table 2-plus signifies moderate improvement, 3-plus considerable improvement, and 4-plus recovery.)

* The capital letters are the patients listed in Table I.

must in some way affect living matter. These considerations, together with the initiative of Dr. F. D. John and Dr. A. J. Carlson, both ardent advocates of the internal use of radium, prompted us to try radium chloride injections in some of our cases to observe its clinical results and to measure the rate of elimination by accurate scientific measurements. Our study might serve as an inducement to others to make better and more intelligent observations. After all, not a few valuable achievements in medicine came into existence largely through empiricism or accident.

In this paper we are primarily concerned with the retention of radium in the human body after injection of a given quantity of radium. Hence, the clinical data are given only in a very abbreviated manner and as a sort of appendix. Thirty-two cases were treated with total doses ranging from 70 to 450 micrograms. Only 4 patients received less than 100 micrograms. Of this group, 8 were not available for subsequent measurements. However, since they were followed up by our social service department, they were evaluated from a psychiatric standpoint and are therefore included in the following summary:

PSYCHIATRIC CLASSIFICATIONS

<i>Dementia Praecox</i>		22
Hebephrenic type	8	
Catatonic type	9	
Paranoid type	4	
Unspecified type	1	
Involutional Melancholia		7
Manic Depressive, Depressed		2
Undiagnosed Psychosis		1
Total		32
(Of these there were 9 males and 23 females.)		

RESULTS

Unchanged mental status:

<i>Dementia Praecox</i>		16
Hebephrenic type	6	
Catatonic type	7	
Paranoid type	3	
Involutional Melancholia		4
Manic Depressive, Depressed, (Also tuberculosis)		1
Total		21

Improved mental status:

<i>Dementia Praecox</i>		6
Hebephrenic type	2	
Catatonic type	2	
Paranoid type	1	
Unspecified type	1	
Involutional Melancholia		3
Manic Depressive, Depressed		1
Undiagnosed Psychosis		1
Total		11

This study was not undertaken to establish one more table of percentage of cures or improvements in cases of dementia praecox treated with radium chloride. Therapeutic claims based on such small groups as this one are advanced in the literature all too frequently. The endless variety of medications, coupled with widely contradictory reports of percentage results, bespeak their unreliability which in turn invites thera-

peutic nihilism.

Since there is room for difference of opinions regarding correctness of diagnosis and rate of spontaneous recovery in all such cases as reviewed above, the figures, of course, must be taken *cum grano salis*. Our results were not sufficiently convincing to advocate any superiority of radium chloride over other therapeutic procedures in psychiatric patients.

REFERENCES

1. BARKER, H. H., and SCHLUNDT, HERMAN. The detection, estimation and elimination of radium in living persons given radium chloride internally. II. AM. J. ROENTGENOL. & RAD. THERAPY, 1930, 24, 418-423.
2. SCHLUNDT, HERMAN, BARKER, H. H., and FLINN, F. B. The detection and estimation of radium and mesothorium in living persons. I. AM. J. ROENTGENOL. & RAD. THERAPY, 1929, 21, 345-354.
3. HESS, V. F. Ueber Neuerungen und Erfahrungen an den Radiummessungen nach der gammastrahlenmethode. *Phys. Z.*, 1913, 14, 1135-1141.
4. Health Hazards of Radium Dial Painting, 1933, U. S. Public Health Service. (With permission of the authors, and courtesy of Dr. J. P. Leake.)
5. SEIL, H. A., VIOL, C. H., and GORDON, M. A. The elimination of soluble radium salts taken intravenously and per os. *Radium*, 1915, 5, 40-44.
6. SCHLUNDT, HERMAN, and FAILLA, G., The detection and estimation of radium in living persons, III. The normal elimination of radium. AM. J. ROENTGENOL. & RAD. THERAPY, 1931, 26, 265-271.
7. LIND, S. C., UNDERWOOD, J. S., and WHITEMORE, C. F. *J. Am. Chem. Soc.*, 1918, 40, 465-472.
8. HAHN, O., and HEIDENHEIM, J. Ueber Hochemanierende Radium-Präparate. *Ber.*, 1926, 59, 284.
9. KURBATOW, Iw., Adsorption of thorium X by ferric hydroxide at different pH. *J. Phys. Chem.*, 1932, 36, 1241-1247.



THE PHYSICAL FOUNDATIONS OF CHEST ROENTGENOGRAPHY*

PART III. CONTRAST

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THE term "contrast" may be applied in general to the differences in density occurring in the different areas of the roentgenogram. Adjacent areas must differ in brightness by about 2 per cent or more in order to be distinguishable and, of course, somewhat greater differences in brightness are more readily perceived. The greater the contrast in the roentgenogram, the finer are the differences in roentgen-ray absorption in the subject which become observable. Contrast *should not be made too high*, however, or some areas will be either so dark or so light that little or no detail can be seen in them.

It is a characteristic of photographic materials that they show poorer density differentiation in the lower densities than in intermediate densities. Within the range of densities useful in roentgenography, roentgen-ray film shows a continuous increase in density differentiation with increase of density. At the higher density values, however, the eye becomes increasingly less able to distinguish density differences existing in the film. Thus, the useful density range is restricted by the limitations of the photographic emulsion at the low end of the density scale, and by the limitation in ocular vision at the high end of the scale. Increasing the brightness of the illumination by which the roentgenograms are viewed will increase somewhat the useful density range, and the perception of density differences in the higher densities, but there are practical limits to this procedure also.

These considerations may be illustrated schematically by the diagram of Figure 1(a). Along the base line, intervals of equal intensity ratios are laid off; these intensities may be considered to have been inci-

dent on the roentgen film, and vary depending on the degree of absorption the roentgen rays have encountered in traversing different portions of the patient. The photographic blackening produced by each intensity, as judged by the eye in viewing the roentgenogram as a whole, is represented by the vertical height of the column above each intensity value. Thus, these blackenings, produced by the successive intensity values, form a series of steps which represent the density differentiation, or contrast, between successive blackenings of the film. At the lower end of the scale, these steps are small, but they increase in height as the blackenings become greater; this is due to a characteristic property of photographic emulsions. For the intermediate range of blackenings, the successive steps are about equal in height, showing a fairly uniform degree of contrast in this range. In the higher blackenings, the successive steps gradually diminish in height until a point is reached where no differentiation is visible; the steps appear to level off to a constant degree of blackening. This loss of contrast in the higher blackenings does not really exist in the roentgenogram, but is due to the inability of the eye to see it. For given conditions of illumination of the roentgenogram, the total useful range of blackening is fixed, by the maximum transparency of the film at one end of the scale, and by the maximum blackening through which the eye can see light at the other end of the scale.

Suppose that by some means the roentgenographic contrast is doubled, that is, the stepped differences in blackening are doubled in height. Assume also that the blackening corresponding to an intermediate intensity, say 8, in Figure 1(a), is

* Communication No. 503 from the Kodak Research Laboratories.

unchanged. Only the *differences* in blackening, and not general over-all blackening of the roentgenogram, are increased (Fig. 1(b)). It is apparent that density differentiation, as represented by the heights of the steps, has been increased only in the intermediate blackenings, over the intensity range 4 to 16. Beyond this range, at both ends of the scale, density differentiation has diminished. At the extreme ends of

greater than the optimum value. The highest blackening in the area of diagnostic interest will then have shifted into the region where contrast is diminishing, and some density differentiation will be lost. If the general blackening is less than the optimum value, the lowest useful blackening then drops into a region of lower contrast. If these same steps (4 to 16) are rendered by the lower contrast of Figure 1(a), the

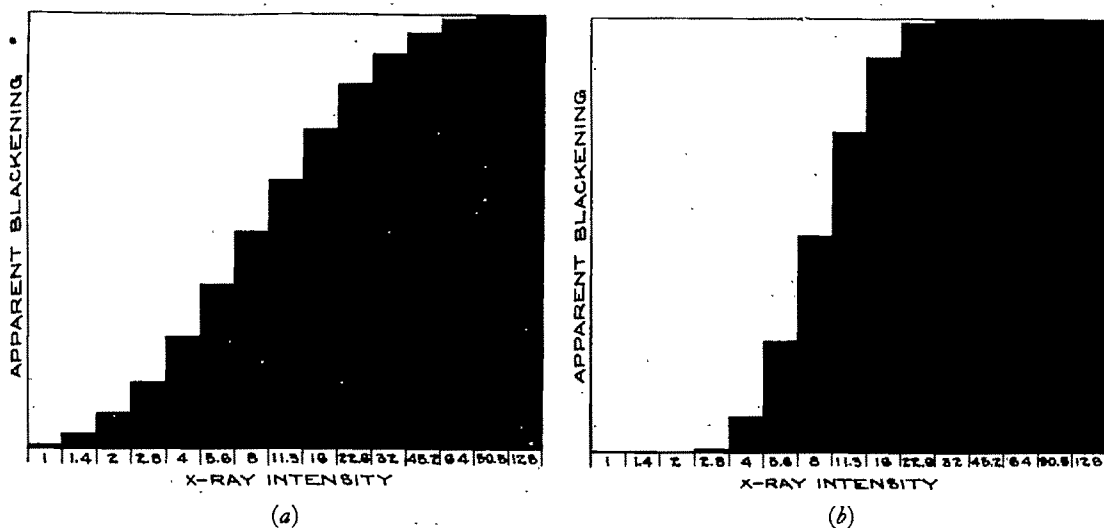


FIG. 1. Diagrams illustrating general relationship between the roentgen-ray intensity ratios incident upon the film and varying degrees of the resultant blackening as perceived by the eye, (a) for a roentgenogram of moderate contrast, and (b) for a roentgenogram of high contrast.

the intensity scale, density differentiation which was visible with the lower contrast had disappeared completely at the higher contrast (steps 1, 1.4, 2, 32, 45.2, and 64.)

If the area of diagnostic interest is rendered entirely within the steps 4 to 16, then the higher contrast of Figure 1(b) is more suitable than that of Figure 1(a), but if it comprises blackenings outside the range, then the contrast of Figure 1(b) is excessive.

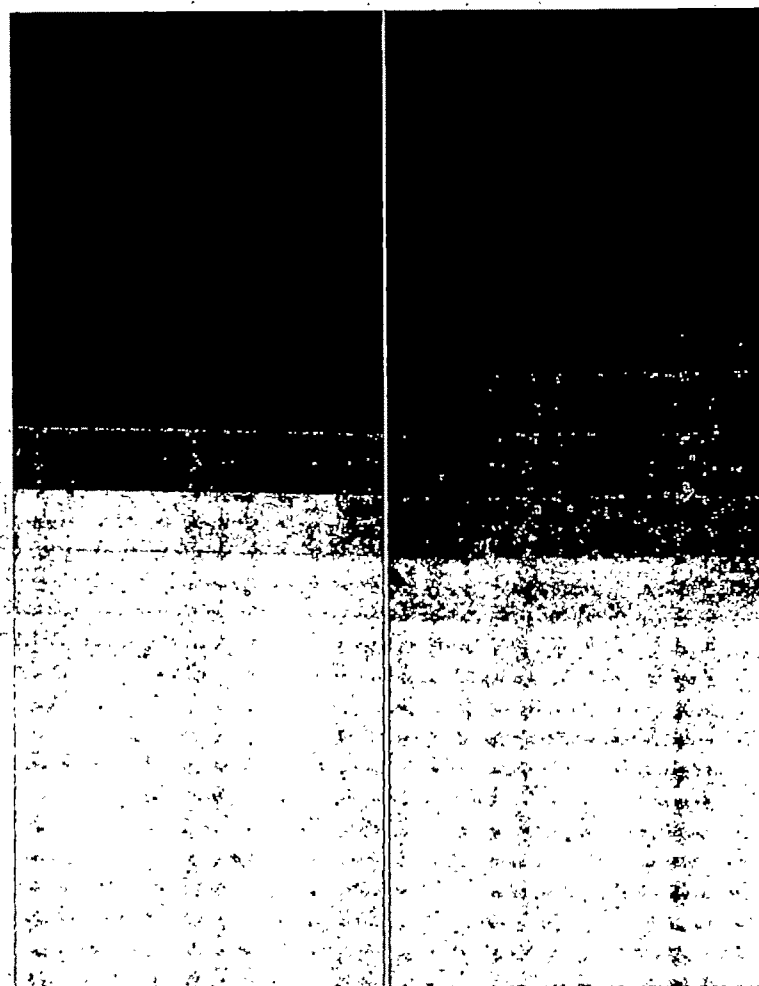
Let us assume that, for a given case, the area of diagnostic interest is rendered by the steps of blackening 4 to 16, so that the contrast indicated in Figure 1(b) is properly adapted to this roentgenogram. Suppose that a similar roentgenogram is exposed, but, by reason of error in exposure or development, the degree of blackening is

general degree of blackening can be raised or lowered somewhat without appreciable loss of density differentiation at either end of the scale. In other words, the lower contrast permits a greater latitude or variation from correct exposure and development.

These considerations show that some disadvantages, as well as advantages, are associated with high roentgenographic contrast. Contrast may not be increased safely beyond the point where essential detail is lost in either the higher or lower blackenings of the area of diagnostic interest, for the normal variations that occur in exposure and development. The more accurately correct exposure and development can be maintained, the higher may be the roentgenographic contrast.

These principles are illustrated photographically in Figure 2, which shows two roentgenograms of an aluminum step

which show appreciable differentiation in the high voltage roentgenogram are lost completely in the low voltage roentgeno-



Low Kilovoltage

High Kilovoltage

FIG. 2. Aluminum stepladder roentgenographed at two tube voltages. As tube voltage decreases, contrast in the intermediate steps increases, while the number of steps shown, and the density differentiation in the highest and lowest densities, both diminish.

wedge exposed at tube voltages giving quite different degrees of contrast. In the roentgenogram made at the low voltage, the contrast in the intermediate blackenings is greater than in any portion of that made at high voltage. Associated with this higher contrast, however, is the fact that a smaller number of steps are visible than in the low voltage roentgenogram; a number of steps near the ends of the scale

gram. Thus, the low voltage roentgenogram exhibits a gain in contrast in the intermediate blackenings, accompanied by a loss, or even disappearance, of contrast in the higher and lower blackenings. The upper limit of roentgenographic contrast should be that which not only avoids loss of contrast in any portions of the area of diagnostic interest, but also allows sufficient leeway for the unavoidable

variations in exposure and development.

At the present time, it is possible to point out only the general principles governing contrast, range of blackening, and latitude of exposure and development; much additional investigation will be required to make quantitative recommendations on these factors.

Roentgenographic contrast depends both upon the contrast characteristics of the roentgen film and upon the penetration of the rays making the exposure. In general, increased contrast of film is associated with a slower film speed, so that this method of increasing contrast requires an increase of exposure just as does the use of lower penetration secured by a lower tube voltage.

If higher contrast is secured by reducing tube voltage or by using a slower film, there is only one way in which the necessary increase in exposure can be produced without material sacrifice in other qualities of the chest roentgenogram, and that is by an increase in tube current. It has already been found that the exposure time should preferably not exceed $1/20$ or $1/15$ second, and to avoid excessive distortion, the target-film distance should be at least 4 feet. After reaching these limitations, the only legitimate additional compensation for the effect of a decrease in tube voltage is an increase in tube current.

There is some degree of interrelation between sharpness and contrast. The contrast between two adjacent densities appears greater if the dividing line is sharp than if this boundary is diffuse. On the other hand, the sharpness of such a dividing line appears to be improved by an increase in contrast between the two areas. Consequently, a change in technique which increases contrast and also diminishes sharpness may leave the resultant definition, and diagnostic value, about the same as before. If the loss in sharpness is small, and the gain in contrast fairly large, the result may be a net gain in effective definition. For instance, the use of the Potter-Bucky diaphragm necessitates an increased distance between patient and film; on

a purely geometric basis, the sharpness should be poorer with the Potter-Bucky diaphragm than without it, and this loss of sharpness is frequently observable in roentgenograms made with the Potter-Bucky diaphragm. However, tests with a water phantom have shown that if the Potter-Bucky diaphragm is designed to make the distance between patient and film a minimum, the loss in geometric sharpness is small, and the improvement in contrast produced by the removal of scattered radiation is sufficient to overcome this deficiency and actually to improve the effective definition.¹

SCATTERED RADIATION

The problem of scattered radiation has been given very little attention in chest roentgenography. The application of the Potter-Bucky diaphragm to chest roentgenography would introduce an additional complication, and it is desirable to ascertain first whether such a procedure would be worth while, at least as a routine method. It is possible to measure the relative proportions of scattered and direct radiation reaching the film in the roentgenography of any part of the body. Such measurements, applied to a group of chests of medium size, showed that, on the average, slightly over half the radiation reaching the film was scattered radiation. Less than half the radiation is employed in forming the roentgenographic image; the rest merely produces a general fogging effect. This scattered radiation not only reduces contrast, but also masks the effect of variation of voltage upon contrast, since the latter method changes contrast in only the direct, image-forming rays.

The proportion of scattered radiation is not uniform in all portions of the chest roentgenogram. In the group studied, the proportion of scattered radiation in the shadows of the apices averaged about 50 per cent. The proportion of scattered radiation was highest in the outer borders of the

¹ Wilsey, R. B. The efficiency of the Bucky-Diaphragm principle. *AM. J. ROENTGENOL.*, 1922, 9, 58-67.

lung area, where the scattered radiation averaged 65 per cent, and the primary radiation 35 per cent, of the radiation rendering these areas on the film. Outside the apices and the outer border of the lungs, the proportion of scattered radiation was found to depend largely on tissue density, varying from about 40 per cent in areas where there were few lung markings, to about 60 per cent where the greater concentrations of lung tissue occur near the lower borders of the heart. Occasional observations showed proportions of scattered radiation as high as 75 per cent; these usually occurred near the borders of the lungs.

In large patients, particularly of the fleshy type, scattered radiation is undoubtedly a much more serious matter than in the case of patients of average size and build, such as were used to secure the above observations.

Scattered radiation diminishes both the contrast and the apparent sharpness of the image formed by the primary radiation. The attempts to increase contrast by a reduction in tube voltage, and to secure finer definition by use of a smaller focal spot, shorter exposure time, or synchronization of the exposure with the heart cycle are all obscured to a considerable degree by scattered radiation. In fact, the more that detail is beclouded by scattered radiation, the less is it affected by any change in tube voltage, size of focal spot, or exposure time. Logically any effort to improve the roentgenographic image should begin with a removal of scattered radiation; only after this is done can the methods which influence the primary radiation image be fully effective.

In the roentgenography of the thicker parts of the body, both experience and laboratory tests have shown that the use of the Potter-Bucky diaphragm increases contrast more than is possible by any practicable reduction in tube voltage. The Potter-Bucky diaphragm increases contrast most in those portions of the subject farthest from the film, producing a clarity of image impossible to secure in any other

way. The proportion of scattered radiation occurring in chest roentgenography is less than that in the body parts with which the Potter-Bucky diaphragm is commonly used. However, tests with a water phantom, in which the proportion of scattered radiation reaching the film was similar to the higher values observed in chest roentgenography, showed that roentgenography with a Potter-Bucky diaphragm, at 100 kv.p. gave higher contrast and superior rendition of faint detail than could be obtained at 40 kv.p. without it. Furthermore, the energy of the exposure at 100 kv.p. with the Potter-Bucky diaphragm was considerably less than that required at 40 kv.p. without it.

Unquestionably, the areas of a chest roentgenogram which receive the higher proportions of scattered radiation can be improved more by removal of scattered radiation than by any feasible reduction in tube voltage; probably this is true also for areas receiving the smaller proportions of scattered radiation. Further experiments are in progress to test this point.

The application of the Potter-Bucky diaphragm to chest roentgenography will increase the exposure required by two to three times, other factors remaining the same. The use of the Potter-Bucky will also necessitate a new adjustment of tube voltage to secure the proper roentgenographic contrast; tube voltages would doubtless be somewhat higher than those commonly used at present, and this increase of voltage will partly compensate for the increase in exposure required with the Potter-Bucky diaphragm. The extent to which the energy of the exposure must be increased with the Potter-Bucky diaphragm and the consequent readjustment of focal spot size and exposure time will have to be determined after practical experience with the Potter-Bucky has indicated what tube voltage will give the most suitable contrast. Rather than increase tube current unduly, it would be preferable to reduce target-film distance to a minimum of 4 feet, since any choice of a distance

greater than this is of negligible importance compared to removal of scattered radiation.

It may be computed from the theory of Bouwers, as developed in Part II, that the increase in energy of the exposure made necessary by the Potter-Bucky diaphragm will cause a slight increase in unsharpness. The increased contrast, however, will doubtless more than compensate for this, and should provide a resultant definition superior to that obtained without the Potter-Bucky diaphragm.

SUMMARY

The general considerations governing roentgenographic contrast are outlined. As a rule, increasing contrast increases visibility of detail, but there are practical

limits to the improvement obtainable by this method. Contrast should not be increased beyond the point where essential detail begins to be lost in the higher and lower blackenings of the roentgenogram; it is preferable to stop short of this limit in order to have sufficient latitude to allow for the unavoidable deviations from correct exposure and development.

In the average chest roentgenogram, scattered radiation forms more than half the radiation reaching the film; in some areas the proportion of scattered radiation commonly reaches 60 or 65 per cent. The adaptation of the Potter-Bucky diaphragm to chest roentgenography should, therefore, materially improve the contrast and clarity of the roentgenographic image.



ENERGY CONSIDERATIONS IN MEDIUM AND HIGH VOLTAGE THERAPY

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ABSTRACT

Previous calculations¹ of the energy per roentgen are extended to the region where photo-electric absorption must be taken into account. A graph of calculated values covering the region from 20 to 1,000 kv. equivalent voltage is given.

The erythema dose is calculated on certain assumptions and plotted against equivalent voltage for the same range. This curve shows a distinct minimum at 80 kv.

The importance to the radiologist of the erythema dose is emphasized and it is pointed out that it must be determined with a large beam. It is shown that the total energy delivered when one erythema dose is given increases rapidly with voltage and with filtration. This increase together with the increase in depth dose is considered evidence for the superiority of hard radiation in deep therapy.

INTRODUCTION

IN A previous paper we have discussed the relation between energy of radiation and the roentgen for the region in which the photo-electric absorption can be neglected, i.e., above 100 kv. From these relations and the assumption that biological effects depend solely on the energy absorbed and are independent of wave lengths we calculated the number of roentgens which could be expected to produce an erythema of the skin and also the total energy delivered to the body when this dose was given. These calculations were made for monochromatic radiation, but it was suggested that for practical purposes radiation such as is used in deep therapy might be characterized by an equivalent wave length or equivalent voltage based on the half-value layer of water.

In the present paper we shall extend the

same treatment to include the region in which the photo-electric absorption is important. Again the calculations apply to monochromatic radiation but it is much more doubtful if in this region the equivalent voltage as here defined is a very useful notion. It is also doubtful if any other simple definition would have much validity except possibly one based on the initial absorption in water. Nevertheless, the general trend of the several curves is instructive and it should be possible to test them at least qualitatively even for the lowest voltage used in deep therapy.

ENERGY PER ROENTGEN

In this case the energy absorbed in 1 cm.³ of air when E_0 ergs of radiation falls upon it is

$$E_a = (\sigma_a + \tau_{air}) E_0 n_a \quad (1)$$

where σ_a as before is the scattering absorption coefficient, τ_{air} the photo-electric absorption coefficient for air $n_a = 3.92 \times 10^{20}$ electrons per cm.³ of air. The energy required to produce one e.s.u. of charge in the form of ions is 0.107 ergs and we have therefore

$$E_0 = \frac{0.107 \text{ ergs per cm.}^3 \text{ per}}{n_a (\sigma_a + \tau_{air}) \text{ roentgen}} \quad (2)$$

Siegbahn gives $\mu/\rho = 2.6$ in air for $\lambda = 1 \text{ \AA}$. From this we obtain $\tau_{air} = 79.1 \times 10^{-26}$ for $\lambda = 1 \text{ \AA}$ and as τ_{air} is proportional to λ^3 we can calculate τ_{air} for all wave lengths shorter than the K limit of any element involved.

This enables us to evaluate equation (2). The result is shown graphically in Figure 1 which should be compared with Figure 4 in the previous paper. It will be noted that the curves are identical for high voltage but

¹ Lauritsen, C. C. Energy considerations in high voltage therapy. *Am. J. ROENTGENOL. & RAD. THERAPY*, September, 1933, 30, 380-387.

drastically different below 100 kv. as they obviously must be.

It is clear that the measurement of intensity at very low voltage is fraught with difficulty and a thorough understanding of the problem of absorption is essential to

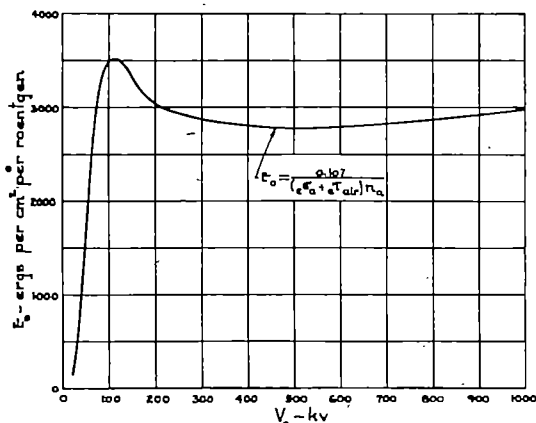


FIG. 1. Total energy falling on 1 cm.² when one roentgen is delivered. V_e = equivalent voltage.

the correct interpretation of the measurement. It is equally clear that if no biological wave-length dependence exists we can expect small, light biological samples in air to behave like air, i.e., a given number of roentgens should produce a certain effect on a given material regardless of wave length. The curve should therefore apply equally well in all such cases.

ABSORPTION IN WATER

If the material is less similar to air and if we use a wide beam then the beam is appreciably modified by the material, and the more the beam is modified the greater will be the variation in the number of roentgens required to produce a given effect. It should be noted that this is in no sense a biological wave-length dependence, but merely a result of the peculiarities of the roentgen unit, for when the intensity is correctly determined by means of an open air chamber, the ionization is due only to the so-called true absorption for which the coefficient per electron is $e\sigma_a + e\tau_{air}$, while in the case of a large body, say water, and a beam of large cross section there is an

additional term due to the ultimate absorption of radiation which is scattered backward. If as before we let $e\sigma_b$ be the coefficient for radiation scattered more than 90° we can write the absorption coefficient applying to a superficial layer of water in the form $e\sigma_a + e\sigma_b + e\tau_{water}$, and we have for the energy E_s absorbed in this layer

$$E_s = (e\sigma_a + e\sigma_b + e\tau_{water}) n_s E_0 R \text{ ergs per cm.}^2 \quad (3)$$

which gives

$$R = \frac{E_s}{(e\sigma_a + e\sigma_b + e\tau_{water}) n_s E_0} \quad (4)$$

and making use of equation (2)

$$R = \frac{E_s (e\sigma_a + e\tau_{air})}{0.107 (e\sigma_a + e\sigma_b + e\tau_{water})} \frac{n_a}{n_s} \quad (5)$$

We can calculate $e\tau_{water}$ using the value $\mu/\rho = 3.8$ for water and $\lambda = 1 \text{ \AA}$ (Siegbahn). The other coefficients are given in Figure 2 of the previous paper.

If we again consider the layer to be a surface layer of water 1 mm. thick and $E_s = 1.4 \times 10^4$ ergs, $n_s = 3.36 \times 10^{22}$ electrons per cm.² of this layer, we obtain the curve (Fig. 2) which should be compared with Figure 5 of the previous paper. The curves are identical at high voltage but quite different at low voltage.

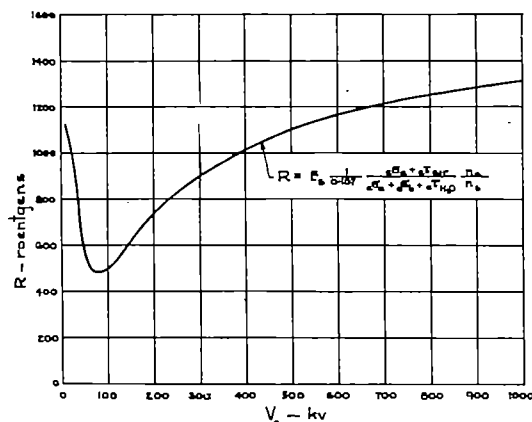


FIG. 2. Total number of roentgens required to cause absorption of 1.4×10^4 ergs per cm.² of a surface layer of water 1 mm. thick. This should be approximately equal to an erythema dose. V_e = equivalent voltage.

We are justified in expecting that if at any given wave length the number of roentgens indicated by the graph of Figure 2 is delivered to human skin using a large portal, it will in general produce an effect upon the skin which can be identified with some degree of erythema. If this is not so we must conclude either that the method of calculation here used is incorrect or that there is a biological wave-length dependence regarding the nature of which we are still in complete ignorance.

Our curve shows a distinct minimum for the number of roentgens required to produce an erythema. This minimum lies at about 80 kv. and the curve rises quite rapidly on both sides. In practice the minimum cannot be as sharp as the curve indicates for we are always dealing with a continuous spectrum which can be represented by an equivalent homogeneous beam only in first approximation. This will tend to make the minimum less sharp and distinct but it should be readily detectable experimentally. It is my understanding that this phenomenon is well known to radiologists who work with soft roentgen rays for superficial work.

The total energy delivered to a body when E_s ergs are absorbed in the surface layer is

$$E_0 = \frac{E_s}{(\sigma_a + \sigma_b + \sigma_{\text{water}})n_s} \text{ ergs per cm.}^2 \quad (6)$$

Using the same numerical values as above this expression gives us the graph shown in Figure 3, which should therefore be a reasonably reliable estimate of the total energy delivered to a body when one erythema dose is given.

It is perhaps well to call attention to the fact that although the equations here used should hold reasonably well for the cases here considered they cannot be expected to be applicable to the calculation of depth doses in this simple form. This is because of the gradual softening of the radiation with depth which is particularly marked with heavily filtered radiation.

DISCUSSION

The process of absorption of radiation is in general a very complicated one and we have seen in the foregoing that we must analyze it in some detail before we can make comparisons between various effects of radiation. To the best of our knowledge

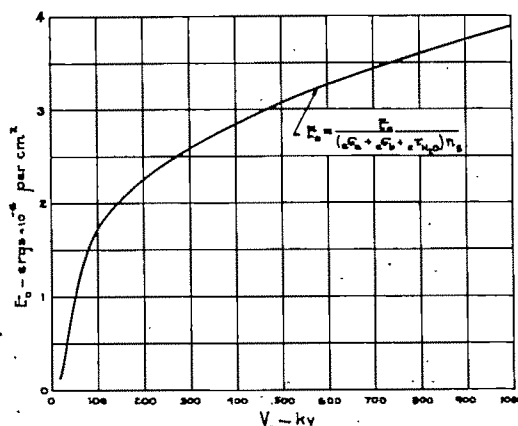


FIG. 3. Total energy delivered for 1.4×10^4 ergs absorbed per cm.² of a surface layer of water 1 mm. thick. V_0 = equivalent voltage.

there is so far no definite experimental evidence for a biological wave-length effect when we base the comparison on equal amounts of energy absorbed, but we cannot say that such an effect does not exist. What we can say is that if no such wave-length effect exists, then we should expect a given number of roentgens to produce a certain effect when and only when the mechanism of absorption is the same in the cases compared. Good examples are fly eggs or other light material suspended in air. In such experiments the absorption mechanism is almost identical with that for the open air chamber with which we determine the number of roentgens. It is therefore obvious that a given number of roentgens is equivalent to a given amount of energy absorbed and we should expect the same effect independent of wave length. It would be strange indeed if this were not so. On the other hand, the effect on a large body must, as we have shown in general, be very different, and we can therefore expect a great difference in the

erythema dose for different wave lengths except when an extremely small beam is used, say 1 cm. or less in diameter.

In practical therapy we are usually dealing with large bodies and large beams and it is clear therefore that neither the air chamber nor the fly eggs nor the skin effect of a small beam give the radiologist any useful information beyond telling him the number of roentgens delivered in a given time. In the treatment of cancer the radiologist has no guide other than the skin reaction and general clinical observations. Great as is the uncertainty and variation in the erythema dose its importance to the experienced radiologist can hardly be overestimated, for in most cases of deep-seated tumors the success or failure depends on the skin reaction, no matter what the wave length of the radiation is.

These are some of the reasons why ra-

diology is still an art and probably will remain so for some time to come.

It should be clear from the foregoing that the best possible filter to use in connection with high voltage roentgen rays is that with the highest atomic number. Lead is very satisfactory. The thickness of filter used must of course be determined from practical considerations. The thicker the filter, the harder the radiation, but there is a limit to the sacrifice one can make in intensity.

The notion that an increase in the focal skin distance produces results similar to increased filtration or higher voltage is based on a misconception. This distance has no bearing on the energy delivered at a given depth except so far as it determines the size of port which must be used to cover a given region. The focal skin distance must therefore be determined solely from practical considerations in a given case.



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Nineteenth Annual Meeting: Cleveland, Ohio, June 10-11, 1934.

E D I T O R I A L

THE AMERICAN CONGRESS OF RADIOLOGY

OLIVER WENDELL HOLMES once said: "Science is the topography of ignorance. From a few elevated points we triangulate vast spaces, enclosing infinite unknown details. We cast the lead, and draw up a little sand from abysses we shall never reach with our dredges."

In the great Hall of Science at the Century of Progress exposition in Chicago are displayed the grains and lumps of sand which constitute our knowledge of the basic sciences gleaned during the last hundred years. These bits of information gathered from the abysses are displayed in a unique fashion on the three great floors of the Hall, unfolding the stories of the discoveries of science and invention which have made the forces of Nature the servant of man and which are responsible for the incredible progress in the last century, of how science has added to the comfort and safety of man and is now used in his service and of the promises it offers for future benefits to man.

For the first time in an international exhibition are included the medical sciences demonstrating their dependence on the basic sciences in an effort to show the public that medicine is no longer veiled in mystery but is a science as well as an art and that those who practice it, to be successful, must be grounded in the basic sciences. Here are displayed the marvelous progress that the medical world has witnessed during the past hundred years which included such epoch-making episodes as the discovery and administration of ether, the great discoveries of Pasteur which opened up the whole field of bacteriology, as well as the epoch-making work of Koch in the discovery of the tubercle bacillus and the monumental work of Lister in the application of Pasteur's discoveries to the

work-a-day world of medicine, and last but not least the epochal work of Faraday and the great group of scientists working in the realm of pure physics out of which ultimately came Roentgen's discovery of the x-ray.*

When Roentgen, working in the realm of pure physics, cast the lead and brought forth the grain of knowledge which he designated the x-ray, he could not know that this weapon which has been added to the armamentarium of medicine would go far toward the elucidation of some of its most intricate problems. How could he know when the *Journal of the American Medical Association* in 1896 in commenting on the recent discovery of Roentgen had this to say, among other things: "The fact that we have . . . a force . . . that will act . . . through flesh, cartilage, skin, and other tissues of the animal body is enough to be fertile of practical suggestions to any thinking physician or surgeon . . . it hints of future valuable physiologic revelations as well as diagnostic aids. It is only a hint, however, and whether it is to be ever realized to any extent is perhaps open to serious question." In controversion of such a prophecy are exhibited some of the splendid achievements in medicine which the utilization of the roentgen ray and radium have brought forth, and not only the contributions which the roentgen ray has made in the field of pure medicine but also such fundamental discoveries as have been made in the application of the roentgen ray to physical and chemical problems, this agent contributing enormously to a newer conception of the finite structure of matter, so much so that a great field of knowledge in pure physics is as a result of these discoveries, about to be "plowed under" and a new "crop" of theories evolved as a substitute for some of the less tenable ones which have been built

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When Roentgen, working in the realm of pure physics, cast the lead and brought forth the grain of knowledge which he designated the x-ray, he could not know that this weapon which has been added to the armamentarium of medicine would go far toward the elucidation of some of its most intricate problems. How could he know when the *Journal of the American Medical Association* in 1896 in commenting on the recent discovery of Roentgen had this to say, among other things: "The fact that we have . . . a force . . . that will act . . . through flesh, cartilage, skin, and other tissues of the animal body is enough to be fertile of practical suggestions to any thinking physician or surgeon . . . it hints of future valuable physiologic revelations as well as diagnostic aids. It is only a hint, however, and whether it is to be ever realized to any extent is perhaps open to serious question." In controversion of such a prophecy are exhibited some of the splendid achievements in medicine which the utilization of the roentgen ray and radium have brought forth, and not only the contributions which the roentgen ray has made in the field of pure medicine but also such fundamental discoveries as have been made in the application of the roentgen ray to physical and chemical problems, this agent contributing enormously to a newer conception of the finite structure of matter, so much so that a great field of knowledge in pure physics is as a result of these discoveries, about to be "plowed under" and a new "crop" of theories evolved as a substitute for some of the less tenable ones which have been built

up around the nucleus and the atom. All of the various basic sciences are grouped in such a manner as to dovetail into the whole scheme of the arrangement of the building, showing admirably the interrelation of the basic sciences with medicine.

Within the shadow of this great hall the first American Congress of Radiology held its meeting under the presidency of Dr. Henry K. Pancoast. The Congress consisted of the membership of the four roentgen and radium societies of the Americas, and the program which was so admirably arranged by Dr. G. E. Pfahler and his committee attested to the enormous progress that the roentgen ray and radium have made in the field of diagnostic and therapeutic medicine since their discovery in the last half of the last century.

There were certain by-products of the meeting which added a great amount of interest and not the least of these was the publication of the "Science of Radiology" edited by Dr. Otto Glasser. This source book prepared by special authorities represents an adequate and comprehensive presentation of the history and development of radiology, the American achievements in this field being given primary consideration, with much added mention of the contributions by radiologists, their clinical confrères, physicists, chemists and biologists from other nations. In addition a Portrait Catalogue of the members and associate members of the Congress was given to each member. The compilation

of this Catalogue was a very happy thought on the part of those who had to do with the organization of the Congress as it gives a short but intimate medical biography of the various radiologists and physicists of the Americas.

All in all, the first American Congress of Radiology was a great success as evidenced by the quality and character of the program, the scientific exhibit, among which was an interesting display of old books dealing with the whole history of electricity from its beginning to the discovery of the roentgen ray, and a splendid exhibit of x-ray tubes, and the technical exhibits in which were shown all the latest developments in apparatus by the manufacturers of roentgen-ray equipment.

To the various local committees which had to do with the physical arrangements of the meeting as well as the scientific aspect of it are due great credit. As so often happens in meetings of this kind the burden of the work usually falls upon a few, and the various societies who participated in the Congress owe very great thanks to Dr. B. H. Orndoff who as chairman of the Executive Council worked untiringly to assure the success of the meeting.

The Congress was not only an exposition of the present accumulated knowledge and experience in the various fields of endeavor in radiology but it offered an opportunity for a combined expression of opinion of a large group as to the future aspirations and ideals of radiology as a specialty.



SOCIETY PROCEEDINGS CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.

Annual Meeting: 1934, to be announced.

AMERICAN COLLEGE OF RADIOLOGY

Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.

Annual meeting: Cleveland, 1934.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.

Annual meeting: Cleveland, Ohio, June 11-15, 1934.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.

Annual meeting: 1934, to be announced.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY

Secretary, Dr. R. T. Taylor, Los Angeles, Calif.

Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.

Annual meeting: Richmond, Va., November, 1933.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N. Y.

Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.

Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. R. G. Willy, 1138 N. Leavitt.

Meets second Thursday of each month October to May inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. Otto Glasser, Cleveland Clinic.

Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital.

Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.

Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill.

Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. N. Collins, Indianapolis, Ind.

Annual meeting each February 22 in Indianapolis.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Kalamazoo, Mich., October, 1933.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.

Meets first Friday in October, December, February and April. Place of meeting designated by the president.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.

Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.

Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY

Secretary, Dr. Major Fleming, Rocky Mount, N.C.

Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. H. S. Bull, 604 Masonic Temple, Auburn, N. Y.

Three meetings a year—January, May and November.

PACIFIC ROENTGEN CLUB

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif.

Meets annually, during meeting of California Medical Association

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Reiley, Clearfield, Penna.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. Karl Kornblum, Graduate Hospital.

Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. W. W. Fray, Strong Memorial Hospital.

Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB

Secretary, Dr. W. K. Mueller, University Club Bldg.

Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston.

Meets at time and place of South Carolina State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY

Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.

Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

VIRGINIA ROENTGEN RAY CLUB

Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.

Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA

Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1, or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.

Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

INDIAN RADIOLOGICAL ASSOCIATION

Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta. Meets annually in January, and at such places and times as the Council may appoint.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY

Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgian).

Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE

Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.

Secretary for German language, Dr. Scheurer, Molzgasse, Biel.

Meets annually in different cities.

SOCIÉTÉ FRANÇAISE D'ELECTROTHERAPIE ET DE RADIOLOGIE MÉDICALE

Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA

Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)

Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.

Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY

Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETÀ ITALIANA RADIOLOGIA MEDICA

Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banul Maracine 30 Bucarest, Rumania.

Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin.

Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY.

Secretaries, Drs. L. L. Holst, A. W. Ssamymgin and S. T. Konobejevsky.

Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. B. Krynski, 11 Zielna St.

Meets once a month except in the summer time.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN

Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY

Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK

Secretary, Dr. H. Scheuermann, Copenhagen.

Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND

Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY

Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION

c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY

Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan. Meets bi-monthly on third Sunday.

FOURTH INTERNATIONAL CONGRESS OF RADIOLOGY

The Fourth International Congress of Radiology will be held in Zurich, Switzerland, July 24-31, 1934, under the patronage of the President of the Confederation. The last days of the Congress and the closing session will be held in St. Moritz (Engadine).

Ordinary members of the Congress can be: (a) members of radiological societies of all countries; (b) persons recommended by such societies. Relations of the ordinary members who wish to take part in the entertainments may attend the Congress as associate members. The membership fee is: for ordinary members, 60.—Swiss Francs; for associate members, 30.—Swiss Francs.

Persons who wish to be registered as members should make application to the General Secretary, Gloriastrasse 14, Zurich, and send the membership fee to the "Schweizerische Kreditanstalt" in Zurich before January 1, 1934.

A list of members will be issued in the form of a portrait catalogue.

At the opening session representatives of the various countries will report on the organization of the cancer campaign in their country. These reports will be published in a special volume.

At the general meetings the following subjects will be taken up:

Roentgen Diagnosis of Bone Tumors.
Vasography.

The Development of Pulmonary Tuberculosis as Seen Roentgenologically.

Radiation Treatment of Carcinoma of the Uterus.

Radiation Treatment of Malignant Tumors of the Mouth and Pharynx.

Radiation Genetics.

Mitogenetic Radiation.

Structure Analysis.

Identical Physical Measurement of the Dose in Roentgen and Radium Treatment.

Hard Gamma Rays, Cosmic Radiation, Earth Radiation.

Short Wave Therapy.

The speakers have been chosen after consultation between the Committee and the radiological societies of the respective countries. Every member is entitled to take part in the discussion. Further, special invitations to participate will be issued by the Committee to certain members. In addition discussions will be held in the six sections and every member is entitled to present a communication of fifteen minutes. The choice of the subject is free, but the Committee suggests the following as being of special interest and will welcome such contributions:

RADIOLOGICAL DIAGNOSIS

Roentgen Kymography.

Factors in the Production of the Mucosa Auto-plastic.

Roentgen Investigation of Skeletal Movement.

Roentgen Investigation of the Mamma.

Sources of Error in Cholecystography.

Gastric Diagnosis Using Air Distention.

RADIOTHERAPY

Possibilities of High Speed Cathode Rays.

Treatment with Highest Tension Roentgen Rays.

Comparison between Teleradium and Deep Roentgen Rays.

Principles in the Construction of Cancer Statistics Showing the Result of Treatment.

Principles and Practice in the Treatment of Metastases (Surgery, Roentgen Rays, Radium, Local and Distant Radium).

The Applications of Radiotherapy to the Sympathetic System.

RADIOBIOLOGY

The Quantum Problem with Respect to Radiobiology.

The Relation between Quality and Biological Effect of Short Wave Radiations.

Radiohistology.

RADIOPHYSICS AND TECHNIQUE

Protection during Screening.

Measurement of Tension and Current of a Roentgen Tube. Questions of Exposure.

Film vs. Paper.

Chemical Effects of Short Waves Diathermy.

Absorption Effect and the Production of Secondary Radiation (Transitional Effects).

ELECTROLOGY

End-Results of Electrocoagulation.

The Production of Alternating Electric Fields of High Frequency and their Biological Effect.

HELIO THERAPY

Acclimatization to Visible Rays.

Infra-Red Radiation.

Long Ultraviolet Waves.

Members who wish to present a paper should notify the General Secretary before January 1, 1934, and supply him with a typewritten summary (not exceeding 400 words) in German, French or English before April 1, 1934. These summaries will appear in the special volume which will be issued to all the ordinary members before the beginning of the Congress.

In connection with the Congress an exhibition of apparatus, photographic accessories, chemical products and scientific books will be organized. (Applications to A. Strelin, Rämistrasse 7, Zurich.)

The delegates chosen to represent the United States are as follows: Dr. B. H. Orndoff, Chicago, President; Dr. Lawrence Reynolds, Detroit, Vice-President; Dr. Albert Soiland, Los Angeles, Secretary-Treasurer; Dr. Byron H. Jackson, Scranton, and Dr. G. Failla, New York. The President of the Congress is Dr. H. R. Schinz, Zurich, and the General Secretary, Dr. H. E. Walther, Gloristrasse 14, Zurich.

AUDITORY EFFECTS OF ROENTGEN RAYS

A CORRECTION

To the Editor:

I wish to take this opportunity to correct an error that occurred in the article on the "Auditory Effects of Roentgen Rays in Dogs" by myself and Mr. Culler, published in the August, 1933, issue of the Journal.

The error is located in the data of Dog No. 2. On page 217, the means (averages) of the tests are given as 47.7, 48.4, 54.9,

and 55.2, the latter values representing the increased acuity after irradiation. These latter averages are larger than the true means which, with their respective standard deviations, are: 51.8 ± 3.1 , and 53.9 ± 2.3 . The positions of the means on the graph (Fig. 4) on page 219 are correct and coincide with the true values given here.

The gain in acuity, though smaller than originally given, is still a significant change, since no value of P —as calculated with the new averages—approximates the "chance" probability. Computing the table of probabilities with these values, the values for P are found to be 0.0168, 0.0007, 0.0083, and 0.0003. A difference is considered as a chance occurrence when the P value is equal to, or greater than, 0.02.

EDWARD GIRDEN

NEW OFFICERS

AMERICAN ROENTGEN RAY SOCIETY

The following officers were elected for the year 1933-1934, American Roentgen Ray Society, at the first American Congress of Radiology: President: Dr. T. Murphy, Toledo, Ohio; President-Elect: Dr. George W. Grier, Pittsburgh, Pa.; 1st Vice-President: Dr. L. R. Sante, St. Louis, Mo.; 2d Vice-President: Dr. H. J. Walton, Baltimore, Md.; Secretary: Dr. E. P. Pendergrass, Philadelphia, Pa.; Treasurer: D. E. L. Jenkinson, Chicago, Ill.; Member of Executive Council: Dr. Sherwood Moore, St. Louis, Mo.

NEW OFFICERS

AMERICAN RADIUM SOCIETY

The following officers were elected for the year 1933-1934, American Radium Society, at the first American Congress of Radiology: President: Dr. Rollin H. Stevens, Detroit, Mich.; President-Elect: Dr. William H. Cameron, New York City; 1st Vice-President: Dr. George W. Grier, Pittsburgh, Pa.; 2d Vice-President: Dr. John W. Cathcart, El Paso, Texas; Secretary: Dr. Edward H. Skinner, Kansas City, Mo.; Treasurer: Dr. Zoe A. Johnston, Pittsburgh, Pa.



DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., 105 Rutledge Ave., Charleston, S. C.

DOG BOARD FOR OBTAINING SYMMETRICAL THORACIC ROENTGENOGRAMS

By C. M. VAN ALLEN, M.D.

*From the Department of Surgery, Peiping Union Medical College
PEIPING, CHINA*

THE angular prominences of the dog's thorax in back and front make it difficult to obtain perfectly symmetrical roentgenograms of the chest without the use of a special retaining device. The author has found the device here described the most satisfactory, not only because it fulfills the primary purpose extremely well but also because it greatly facilitates directing the roentgen rays over any chosen point, and is simple and portable.

The base is wooden and has a depression in the upper surface which is converted

into a cassette tunnel by a roof of aluminum. The roof has a deep groove along the middle with flanking elevations, to retain the dog's spine. A pole stands on the base, at the center of one of the sides, which is parallel to the groove, and it carries pivoted on the top a horizontal arm long enough to reach entirely over the cassette tunnel. The arm carries a movable sleeve from which hangs a line and plummet, the line passing through a hole in the sleeve so that it can be pulled up easily. A spring-ratchet on the post fixes the arm in any desired direction,

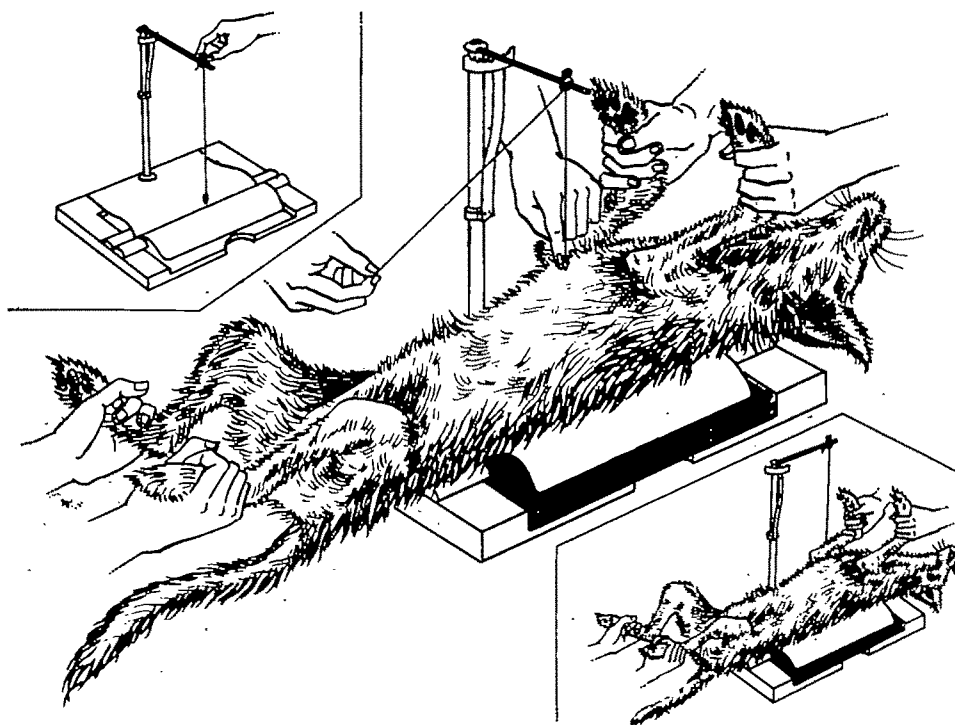


FIG. 1. Above: preparation of the board—centering the plummet over the groove. Middle: placement of the dog—centering the mid-point of the diaphragm (in this case) under the plummet. Below: position at the time of exposure.

and a set-screw on the sleeve fixes that structure at any desired point.

The board is prepared for use (Fig. 1, upper view) by adjusting the position of the arm and sleeve so as to bring the plummet over the point where the rays are to be centered, usually the center of the cassette tunnel (when the arm is put at right angles to the groove and the sleeve is fixed with the plummet hanging directly over the groove). The apparatus is then placed on the roentgen table with the sleeve centered under the roentgen tube, a loaded

cassette is inserted in the tunnel, and the roentgen machine is prepared for the exposure. The dog is placed on the board (Fig. 1, mid view) with the spine in the groove, and the point on the chest over which it is desired to center the rays, usually one on the midline of the sternum, is located with the finger tip, while the plummet is drawn up near the upper surface of the chest and the dog's position is adjusted to bring the finger tip under the plummet. The arm is now swung aside (Fig. 1, lower view) and the exposure is made.

SAFETY DEVICE FOR DOUBLE FOCUS COOLIDGE TUBE*

By FRANK E. WHEATLEY, M. D., and GEORGE LEVENE, M.D.
BOSTON, MASSACHUSETTS

ONE of the reasons why we hesitated to install a double focus tube in this laboratory was the danger of accidentally overloading the fine focal spot and ruining the tube. This danger was eliminated by

placing in the fine focus filament circuit a fixed resistance of such capacity that the maximum current through the fine focus

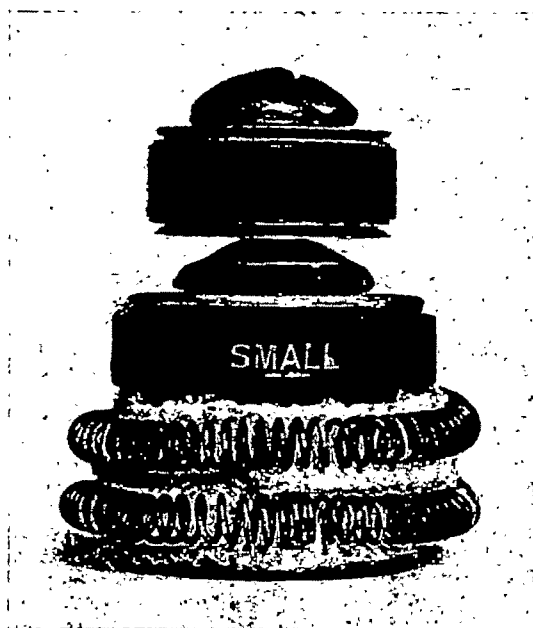


FIG. 1

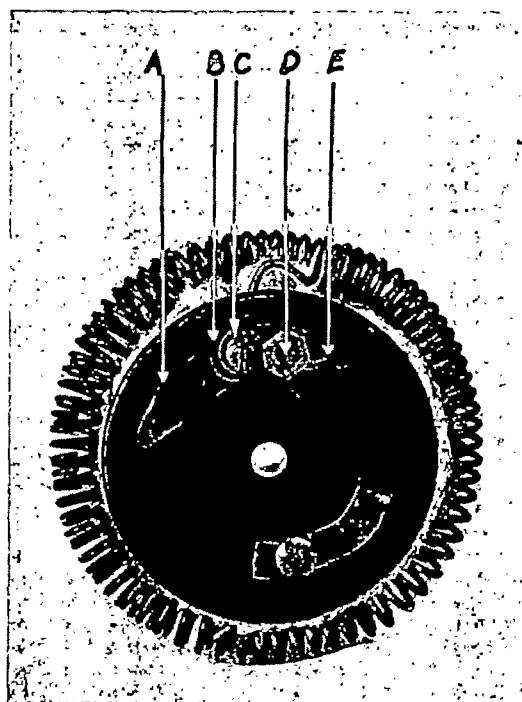


FIG. 2

* From the Department of Roentgenology of the Evans Memorial for Clinical Research and Preventive Medicine, Massachusetts Memorial Hospitals, Boston.

of the tube is 15-20 ma. when the filament control is at its maximum setting. This was accomplished by disassembling the switching device (Fig. 1) on the tube and replacing the bronze spring clip carrying the small filament current with a new and longer one (Fig. 2, *A*) made so that the screw (*C*) which held the old spring is insulated from the new spring by a fiber washer (*B*) through a larger hole in the spring, and a second screw (*D*), placed a short distance back, holds the spring in place and makes contact with it. The resistance wire (No. 18) is wound in a coil of about the diameter of a screen-door spring and this coil is wound in two turns

around the outside of the switching device. The ends of the resistance are passed through small holes (*E*) drilled in the bakelite and are fastened to the screws of the bronze spring clip. A strip of asbestos wicking is placed under the coils and a narrower strip is placed between the coils for heat and electrical insulation. The proper length of resistance necessary to cut the filament current will vary with each installation, and should be worked out by trial. In practice this alteration of the switch can be made by any handy-man with little or no expense and is a workable prevention of unfortunate accidents on the part of the technician.



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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

BISTOLFI, STEFANO. La roentgenterapia nelle malattie a sindrome emorragica. (Roentgen treatment in diseases with a hemorrhagic syndrome.) *Radiol. med.*, 1932, 19, 773-820; 889-933.

The author discusses the physiopathology of various diseases with a hemorrhagic syndrome, including hemophilia, Werlhof's disease, hemorrhagic capillary toxicoses and familial and sporadic pseudo-hemophilias, and considers the action of roentgen irradiation not only in these diseases but in controlling operative hemorrhage.

In all these diseases there are factors both in the blood itself and in the vessels to be considered. It seems to be proved that roentgen irradiation causes increased calcium metabolism, that is, more rapid elimination of calcium by the tissues and consequently a higher calcium content in the blood. It also causes increase of the number of cells, particularly leucocytes and platelets and increased coagulability. The increased number of cells, in addition to improving the general condition of the patient, may have a direct action in producing hemostasis. The rays also seem to have a good effect on obscure factors in the capillary walls. In Werlhof's disease intense irradiation of the spleen should be tried before resorting to splenectomy, and roentgen treatment has also proved effective in the treatment of recurrences after splenectomy.

Increased coagulability is brought about by small doses— $\frac{1}{4}$ to $\frac{1}{3}$ of a skin erythema dose—but the author does not believe that large doses cause retardation of coagulation. The ready hemorrhage sometimes seen after intense irradiation he thinks is caused by leucopenia and decreased number of platelets.

Irradiation should not be applied in all diseases with a hemorrhagic syndrome; it would be absurd to use rays, for instance, in a disease such as scorbutus in which causal treatment is so successful. Irradiation should be tried however in the different hemorrhagic diseases and utilized in those in which it has even a tempo-

rary good effect on the pathogenic factors.—*Audrey G. Morgan.*

ZACCARIA, ANTONIO. Risultato della roentgenterapia in una oscura lesione della teca cranica, diagnosticata come osteoporosi circumscripita di Schüller. (Results of roentgen treatment of an obscure lesion of the skull diagnosed as Schüller's circumscribed osteoporosis.) *Radiol. med.*, Aug., 1932, 19, 857-864.

A case of extensive lesion of the bones of the skull in a peasant twenty-four years of age is described. The author made a probable diagnosis of Schüller's circumscribed osteoporosis of the second type. This diagnosis was confirmed by Schüller himself to whom roentgenograms were sent, and by a number of eminent Italian roentgenologists. The differential diagnosis from syphilis, tuberculosis and Paget's disease is discussed.

The patient was irradiated four times at intervals of five days with doses of $\frac{1}{4}$ of a skin erythema dose, 220 kv., 40 cm. spark gap, 40 cm. focus-skin distance, filter 4 mm. aluminum and 0.5 mm. zinc, Coolidge tube, 2 ma. After a month and a half this series was repeated. This resulted in almost complete recalcification of the decalcified area and almost complete restoration of vision, but the severe headache of which the patient complained persisted, which suggests the possibility that this may be a prodromal stage of Paget's osteitis.—*Audrey G. Morgan.*

JÖNSSON, GUNNAR. Case of xanthomatosis treated by teleradium. *Acta radiol.*, 1932, 13, 518-526.

The author discusses the clinical picture and pathology of xanthomatosis and describes a case in a child born Nov. 29, 1928. In May, 1930, when fifteen months old, she suffered a blow over the left eye, followed by a swelling of the eyelid. This swelling persisted for six months in spite of incision and in January, 1931, another swelling developed in the left temporal region. On admission to the Radiumhemmet, March 16, 1931, she showed another swelling

in front of the ear. She presented exophthalmos and the roentgen and histological picture of xanthomatosis with areas of destruction in the skull bones.

Radium irradiation was given from March 16 to 29, 1931, with Sievert's teleradium apparatus. Four fields were irradiated, one over the eye, one in front of the ear, one at the site of the temporal swelling and one in the parietal region. A total dose of 19.5 gram-hours was given at a distance of 6 cm. with a filtration equivalent to 6 mm. lead. Daily doses of 1.5 gram-hours (3 grams for $\frac{1}{2}$ hour) were given alternately on the different fields. Improvement was noticed during the treatment and on April 14, two weeks after it was finished, the swellings were no longer palpable and there was further improvement in the child's general condition. The middle of June she was given a second series of 1.5 gram-hours over three of the fields.

Since April, 1931, she has shown no clinical evidence of the disease and there has been a steady improvement in the roentgenograms. This is the only case treated with radium that has been published.—*Audrey G. Morgan.*

COLLIN, E. La radiumthérapie du cancer de la lèvre surtout au point de vue de ses métastases. (Radium therapy of cancer of the lip, particularly from the point of view of metastases.) *Acta radiol.*, 1932, 13, 232-238.

The author gives statistics of 101 cases of cancer of the lip all treated with radium. Implantation was used in only 4 cases; in all the rest the treatment was by direct superficial application of 50 to 250 mg. radium element. In some of the cases preliminary treatment was given with hard roentgen rays and in some with soft roentgen rays. He divides the results according to these three groups. The best results were obtained in the group treated with soft roentgen rays followed by radium therapy; in the group treated with radium alone the results were almost as good, and in the group treated with hard roentgen rays and radium they were decidedly inferior. The total percentage of cures was about 80 per cent. The effects of the soft roentgen and radium treatment were particularly good with reference to the development of gland metastases. There was a very small percentage of gland metastases in this group. This was probably because the lymphatic glands react differently to hard and soft rays.—*Audrey G. Morgan.*

BERVEN, ELIS. Le traitement radiologique des tumeurs malignes de la cavité buccale. (Radiation therapy of malignant tumors of the mouth.) *Acta radiol.*, 1932, 13, 213-231.

The Radiumhemmet is now using a combination of teleradium and endothermy for the treatment of the primary tumor in carcinoma of the mouth and a combination of radium and conservative surgery for the enlarged glands. Radium has proved superior to the quality of roentgen irradiation available at present.

The greatest technical improvement in recent years has been the introduction of the teleradium technique and the more widespread use of the interstitial implantation of radium needles in combination with endothermy. By means of the teleradium technique the quantity and quality of the rays and the tissue doses can be increased, which greatly increases the effectiveness of the irradiation. The interstitial implantation of radium needles in various parts of the tumor completes or supplements the dose given in the previous teleradium treatment. Endothermy removes any resistant tumor remnants without bleeding and without any risks of local reimplantation or spreading of the tumor. The routine treatment of the primary tumor consists of an initial teleradium treatment, which after the tumor has become clean, reduced in size and more definitely circumscribed, is followed by endothermy by simultaneous interstitial implantation of radium needles around the coagulated area. The treatment of the enlarged lymph gland areas consists of giving teleradium treatment at the same time the primary tumor is treated. Surgical treatment is indicated after the teleradium treatment if any gland metastases remain that are movable and easily removable. Otherwise only teleradium is used.

For the period of eleven years from 1916 to 1926 the results of radiation treatment have been healing for five years or more in 32 per cent of the cases of carcinoma of the tongue, 34 per cent of the cases of sublingual carcinoma, 18 per cent of those of carcinoma of the mandible and 26 per cent of those of buccal carcinoma. Among 278 patients with carcinoma of the mouth 76, or 27 per cent, are free from symptoms after five to eleven years. Among 28 patients with epithelioma of the tonsils treated from 1919 to 1924 with the old technique 25 per cent were primarily cured and 10 per cent were free of symptoms for one year. Among 18

patients with epithelioma of the tonsils treated from 1924 to 1927 with the new technique, 55.6 per cent were primarily cured and 39 per cent were free of symptoms after three years. Among 25 patients with carcinoma of the tonsils treated from 1916 to 1927 primary cure was attained in 71.4 per cent, 48.6 per cent were free of symptoms for one year and 36.7 per cent for five years.—*Audrey G. Morgan.*

MERRITT, EDWIN A. Irradiation of the parathyroids in cystic disease of the bones. *J. Am. M. Ass.*, May 14, 1932, 98, 1733-1734.

Endocrinologic study has demonstrated a definite relation between the parathyroid glands and the metabolism of calcium in the skeleton and many cases have been reported demonstrating the influence of parathyroid hyperplasia in the causation of cystic disease. This is a report of a case of cystic disease involving the femur which showed complete recovery within four months after administration of roentgen rays to the parathyroid glands was instituted. A series of exposures was given at intervals of three weeks using 5 ma., 135 kv., 10 in. distance and 5 mm. Al filter. Not only was the bone structure restored to normal but the general symptoms of hyperthyroidism and hyperparathyroidism practically disappeared. This case is apparently the first so treated.—*E. W. Hall.*

ROSSONI, RICCARDO. Contributo al trattamento radioterapico del maladie de Vaquez. (Roentgen treatment of Vaquez' disease.) *Radiol. med.*, Feb., 1932, 19, 156-166.

A typical case of Vaquez' disease is described in which the red blood count had risen to 12 million. The patient was given roentgen treatment beginning in February, 1927. The upper and lower epiphyses of the bones were irradiated, so as to irradiate as much bone marrow as possible. Both the dorsal and ventral surfaces were irradiated with $\frac{1}{3}$ of a skin erythema dose per field, making a total of $\frac{2}{3}$ of an erythema dose for each epiphysis. The bones irradiated were the humerus, ulna and radius, tibia and femur on both sides and the sternum. The spleen was not irradiated. Two fields were irradiated a day for fifteen days, with a spark gap of 40 cm., 2 ma., filter 0.5 mm. zinc and 3 mm. aluminum, focus-skin distance 30 cm. The symptoms were accentuated for a little while and then the patient's condition began to im-

prove progressively. Two further series were given in April and June and after that the patient was well for three years. Toward the end of 1930 the red blood count rose again to 7 million and some of the other symptoms reappeared. He was given two series of irradiations in January and February of 1931 and since that time has been well subjectively and objectively with a normal blood picture. The white cells showed leucopenia during the treatment, followed at the end by leucocytosis with no immature forms, showing that the bone marrow was functioning normally.—*Audrey G. Morgan.*

HEYMAN, JAMES. Experiences with radiological treatment of cancer of the uterus and ovaries. *Acta radiol.*, 1932, 13, 329-333.

The author briefly reports the results obtained at the Radiumhemmet in the treatment of cancer of the uterus and ovaries.

From Jan. 1, 1914, to Dec. 31, 1926, a total of 1,237 patients with cancer of the cervix was sent to the Radiumhemmet for treatment. Five years after the treatment 259 of these patients were living and free from symptoms. This is about 20 per cent absolute cures. Of those treated from 1914 to 1921 inclusive 16 per cent were living and free of symptoms.

There were 80 cases of cancer of the fundus in which the microscopic diagnosis was made at the Radiumhemmet from 1914 to 1926. Most of these were adenocarcinomas. Of these 42.5 per cent were living and apparently free of symptoms after five years.

Among the cases of carcinoma of the ovaries treated from 1914 to 1926 there were 24 inoperable cases; two of the patients were living after five years. Microscopic diagnosis was lacking in one of these cases. Among 36 cases operated on conservatively about 20 per cent were living after five years; among 28 recurrences after radical operation 25 per cent were living at the end of five years and among 46 cases operated on radically and given radiation treatment afterward about 54 per cent.—*Audrey G. Morgan.*

NEILL, WILLIAM, JR. 126 cases of ovarian carcinoma treated by radiation. *South. M. J.*, July, 1932, 25, 679-682.

One hundred and twenty-six cases of ovarian carcinoma treated by radiation, both roentgen rays and radium, are reported. Accurate tissue

diagnosis was made in all but 7, there being 108 papillary cystadenocarcinomas, 8 solid cell adenocarcinomas, 2 gelatinous papillary carcinomas and 1 Krukenburg tumor. The ages ranged from thirteen to seventy-five, averaging $42\frac{1}{2}$, with the greatest number appearing in the decade forty to fifty; 106 were married. Eighty-two cases were bilateral. The process was advanced in 112 cases when first seen. In 87 there was no improvement. In 32 there was definite palliation as to relief of pain and improvement of general health, lasting from three months to four years, with later resumption of the growth. Three cases apparently cured lived for 6, 20 and $2\frac{1}{2}$ years, the latter dying of disease independent of the ovarian condition; 2 cases clinically well for 4 years and 3 cases apparently well for 4, 3 and $1\frac{1}{2}$ years are reported in detail with factors of radiation therapy employed.—*W. R. Brooksher, Jr.*

MISCELLANEOUS

PICCHIO, CARLO. Dosimetria curieterapica. (Dosage in radium therapy.) *Radiol. med.*, Sept., 1932, 19, 933-967.

The author gives a thorough review of the methods of radium dosimetry in use at the present time, discussing their merits and their faults. He then says that when the dosage of an apparatus cannot be measured directly by the ionomicrometer he has worked out a relation between the charge per unit of surface and its yield in Dominici units which is sufficiently accurate to be used for practical purposes in determining dosage. The values are affected of course by various factors, such as the distance of the focus from the skin, the filtration and the area over which the irradiation is distributed. He has taken these factors into account in the table which he gives showing his results. The limits of error are small enough so that the method can be used for forms of apparatus that are not too much curved; for these he thinks direct measurement should always be used.—*Audrey G. Morgan.*

BARNARD, MARGARET W., AMBERSON, J. BURNS, JR., and LOEW, MARION F. The technique of using paper films for roentgenograms of the chest. *Am. Rev. Tuberc.*, June, 1932, 25, 752-766.

This is a statement of the technical procedures employed at the Bellevue-Yorkville

Health Demonstration with a new type of paper film. This film, coated on one side, is used practically the same as the celluloid film, requiring an increase in exposure time of 100 to 200 per cent with a slightly increased kilovoltage peak. A special developer is required. After finishing, the film is viewed by direct illumination with bright daylight. While the celluloid film is appreciably superior for showing shadows of fine detail, the paper film approximates this desired standard very closely. It possesses the frequently desired advantage, particularly in a large series, of about 50 per cent less cost. A series of comparative illustrations accompany the article.—*W. R. Brooksher, Jr.*

WHITE, PAUL D., and CAMP, PAUL D. A comparison of orthodiagraphic and teleroentgenographic measurements of the heart and thorax. *Ann. Int. Med.*, Oct., 1932, 6, 469-481.

The authors report on the comparative study of the heart and thoracic measurements in a series of 22 individuals, 10 normal and 12 with abnormalities of the heart, aorta and pericardium. In each of the diameters measured the teleroentgenographic average was greater than the orthodiagraphic, and the thoracic measurements showed greater difference than the cardiac. The transverse cardiac diameter averaged 1 cm. greater by teleroentgenographic measurement than by orthodiagraphic (in an extreme case 1.8 cm.). The cardi thoracic ratio was essentially the same by either method in both groups. Measurements by teleroentgenography were consistently greater as established by controls in all cases. A greater cardiac area measurement by teleroentgenography was a uniform finding and averaged 15 to 25 per cent in these cases. The difference between the two methods is great enough to render direct comparison misleading, and thus in giving roentgen measurements of cardiac and intrathoracic diameters and of the cardiac area, it is essential to state by which method the measurements were obtained.—*W. R. Brooksher, Jr.*

CIGNOLINI, PIETRO. Metodi e mète della chimo-grafia cardiaca (Roentgenmiografia cardiaca.) (Methods and objects of kymography of the heart—cardiac roentgen myography.) *Radiol. med.*, April, 1932, 19, 401-405.

In 1912 Gott and Rosenthal proposed the first method of kymography of the heart. The

x-ray bundle which had traversed the chest of the patient was intercepted by a lead screen except for a narrow fissure running transversely and following a horizontal or oblique diameter of the heart. The roentgen film was moved with a uniform motion behind the lead screen, giving a picture of the successive positions assumed by the heart outline. The movements of the heart were registered in an accurate and legible way. The method had disadvantages, however, and the author mentions various improvements made in it up to his own method in which short segments of the fissure are placed in chosen positions on the heart outline and a kymographic record obtained of the movements of those sections. He takes, for instance, a point on the left ventricle, one on the right ventricle, one on the right auricle and one on the aorta and makes an accurate analysis of their movements which are recorded. He gives illustrations from cases of auriculoventricular dissociation. He thinks the method is a valuable contribution to the study of the physiology and pathology of the circulatory system.—*Audrey G. Morgan.*

ZIEDES DES PLANTES, B. G. Eine neue Methode zur Differenzierung in der Röntgenographie-Planigraphie. (A new method of differentiation in roentgenography—planigraphy.) *Acta radiol.*, May 15, 1932, 31, 182-192.

A method is described by which it is possible to obtain a sharp roentgen picture of any one plane in the object examined while parts lying outside that plane are rendered indistinct. For this purpose the tube and the film or plate are moved in opposite directions throughout the exposure time in such a way that the projection of all points in the plane selected always strike the film at the same place while the projections of all points outside that plane change their position.

A method is also reported which makes it possible to project several planes at the same time and a simple apparatus described by which the height of the plane can be registered. An example is given showing how reliable measurements can be made on the roentgenogram by means of this new method of projection. Some difficulties in the interpretation of the roentgenograms that are of special interest are discussed.—*Audrey G. Morgan.*

JAEGER, W. Über einen scharfzeichnenden Film für Folienaufnahmen. (A film for taking folio

pictures with sharp outlines.) *Acta radiol.*, May 15, 1932, 13, 178-181.

By adapting the construction of a double-coated film to the special optical conditions required for making roentgenograms in folio size, the author has succeeded in obtaining a considerably greater sharpness of outline in the pictures without any changes in the practical manipulation of the films. No increase of exposure time is necessary; the developing time is lengthened a little. Illustrations are given showing the gain in sharpness of outline.—*Audrey G. Morgan.*

RIBBING, S. Beitrag zur röntgenologischen Pelvimetrie und Zephalometrie in utero. (Roentgen measurement of the pelvis and head in the uterus.) *Acta radiol.*, 1932, 13, 591-598.

One of the chief objects of obstetrical roentgen diagnosis is to determine the form and size of the pelvis and of the head of the fetus. The best way of determining the general form of the pelvic inlet is by taking a roentgenogram in Albert's semi-sitting position. The length of the true conjugate can best be measured on a lateral roentgenogram of the pelvis by Guthman's method. The transverse diameter and the head of the fetus can be measured accurately and simply by orthodiagraphy by Moritz' method which does not seem to have been used heretofore in the measurement of the pelvis.—*Audrey G. Morgan.*

FRANKE, HEINRICH. Die Norm im Röntgenbild. (Standards in roentgenography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1931, 44, 691-711.

This is a technical article which through the German Roentgen Society won the first prize of the Schleussner Company. It deals with (1) considerations of the sensitometry of roentgen emissions; (2) the constancy of the roentgen source; (3) the sensitometric system; (4) the relation of the threshold sensitivity, gradation, and fogging to the form and position of the sensitometric curves; (5) the accuracy of the disc of the sensitometer; (6) the sensitometric disc and its systems of exposure; (7) development and gradation; (8) the influence of additional exposure on the gradation; (9) the intensifying factor, and (10) the making of roentgen copies.—*T. Leucutia.*

BRUNETTI, LODOVICO. In difesa del mio metodo personale dell'assunzione crociata dei due canali ottici a cranio fisso su stessa film. (In defense of my personal method of taking the two optic canals crossed on the same film with the head fixed.) *Radiol. med.*, Sept., 1932, 19, 1030-1036.

This is an extremely technical discussion of the author's own method of taking roentgenograms of the optic canals which has been criticized by Prof. Giordano.—*Audrey G. Morgan.*

KREBS, CARL, and SCHMIT-JENSEN, H. O. Experiments with roentgen irradiation of pure vaccinia lymph and of a lymph sample contaminated with foot-and-mouth disease virus. *Acta radiol.*, 1932, 13, 349-361.

Roentgen irradiation of vaccine lymph in doses of from 3,600 to 36,000 r apparently did not decrease its infectiousness. In 275 children scarified on the left arm with irradiated vaccine and on the right arm with non-irradiated vaccine there was not the slightest difference in the results on the two arms. It will require further experiments with titrated doses of virus to determine whether roentgen irradiation has any effect on the total amount of live particles of virus in such emulsions or not.

Roentgen irradiation of a cowpox vaccine accidentally contaminated with a foot-and-mouth disease virus with doses of 38,000 and 25,000 r did not kill the foot-and-mouth disease virus. Two heifers inoculated with irradiated virus and one heifer and a ram inoculated with non-irradiated virus all showed typical generalized foot-and-mouth disease. The authors have the impression that the roentgen irradiation stimulated rather than weakened the effect of the foot-and-mouth disease virus.—*Audrey G. Morgan.*

CAPPELLI, LUIGI. Esperienze sulla celluloid, proposta quale supporto nelle applicazioni radiumterapiche. (Experiments with celluloid as a support for radium preparations.) *Radiol. med.*, Aug., 1932, 19, 825-835.

In a previous article the author proposed the use of celluloid as a support in the application of radium preparations. He has now made comparative chemical and biological experiments with nitrocelluloid and acetyl-celluloid and finds that the latter is superior to the former. The nitric acid in the former is replaced by acetic acid and the camphor by an oil which is

probably castor oil so that the acetyl-celluloid does not cause the slightest irritation. It is non-inflammable and much more plastic than nitrocelluloid. It is much lighter than Columbia paste and cannot be broken or bent, as the latter can. Acetyl-celluloid is as transparent as glass, much more so than nitrocelluloid and the author believes it is the best material available for making radium supports.—*Audrey G. Morgan.*

JANSSON, GÖSTA. Über die Einwirkung der Röntgenstrahlung auf die Fähigkeit der Geschwülste Iod und Wismut zu speichern. (The effect of roentgen irradiation on the capacity of tumors for storing iodine and bismuth.) *Acta radiol.*, 1932, 13, 533-550.

The author describes experiments that he made for the purpose of determining whether roentgen irradiation affects the capacity of tumors for storing bismuth and iodine. With reference to iodine he found that small doses of irradiation do not affect the storage capacity of the tumors. Larger doses decrease the capacity of the tumor for storing iodine, no matter whether the irradiation is filtered or unfiltered. The effect is not apparent for the first twenty-four hours and is not marked until after several days.

The effect on the storage of bismuth is just the opposite. It is increased by irradiation. These statements refer to the immediate effect of irradiation. The observations were not continued for more than a week and it is not known whether there was any later effect.—*Audrey G. Morgan.*

LAMBERT, J. Contribution à l'étude de la radiosensibilité des graines au début de la germination. (Contribution to the study of the radiosensitivity of grains at the beginning of germination.) *Compt. rend. Soc. de biol.*, Oct. 16, 1931, 108, 240-244.

The authors performed a series of experiments on peas in various hydrolyzed conditions by irradiating them in lots of 40 to 50 with a dose of 10,000 r (Solomon), 200 kv., 20 cm. distance, 1 mm. Al filter, 80 min. exposure. It was found that the dry peas were more resistant to irradiation than those soaked for eighteen or twenty-four hours in wet sawdust, but that they were less resistant than those irradiated after six or twelve hours of hydration.—*T. Leucutia.*

LINDBLOM, ADOLF F. On the effects of various iodized oils on the meninges. *Acta med. Scandinav.*, 1931, 76, 395-402.

Odin and Runström in 1928 in dealing with myelography called attention to the irritating effect of the various oils on the meninges. The experiments on which this assertion was based were performed by the author. He since then has continued them and now arrives at the following conclusions: The vegetable oils (soy, linseed, poppy) are less irritating than the animal oils (cod liver oil). The cause of irritation lies in impurities (fatty acids, iodic fatty acids and sometimes hydrogen iodide) in the vegetable oils, and in very rapid splitting in the animal oils. If the impurities are eliminated, vegetable oils may be used safely as contrast media. Still one has to consider that under certain conditions a fatty granuloma may occur later. The animal oils are entirely useless and should therefore be rejected.—*T. Leucutia*.

LAMBIN, P. Influence du dioxyde de thorium colloïdal (thorotrast) sur la formule sanguine. (Influence of colloidal thorium dioxide (thorotrast) on the blood formula.) *Compt. rend. Soc. de biol.*, Oct. 16, 1931, 108, 264-266.

The authors studied the hematologic modifications secondary to injections of thorotrast in rabbits. It was found that a large dose of 5 c.c. produces a distinct anemia whereas smaller doses of 1 c.c. may lead to a discrete erythroblastic reaction. It was interesting that the reticulocytes presented no increase in number after twenty-four hours. It seems thus that the thorotrast produces an initial erythroblastosis without reticulocytosis, similar to that observed by Wuyts and Morelle after injection of saponin and colloidal sulphur. The variations in the total number of red and white elements resembled those observed after the injection of most of the colloidal substances. An initial and generally very short phase of leucopenia with relative lymphocytosis was followed by a long phase of leucocytosis with polynucleosis. The peak of the polynucleosis was occasionally followed by monocytosis and after stronger injections by passage into the blood of histiocytes loaded with thorotrast.

A long sojourn of the thorotrast in the reticulo-endothelial cells fortunately permits the injection of the thorotrast in fractional doses, thus preventing the occurrence of anemia, but

it remains to be determined whether or not this produces a radioactive effect on the organism in general and on the hematopoietic system in particular.—*T. Leucutia*.

OSMENT, C. G. Experimental radiography utilizing the gamma rays of radium. *Brit. J. Radiol.*, March, 1932, 45, 269-274.

Considerable benefit is derived from the use of radium as a source of radiation in the examination of metals. With the known apparatus rather successful results have been obtained with the roentgen rays for thicknesses of steel and iron up to about $3\frac{1}{2}$ inches. The introduction of gamma rays of radium would permit radiography of the metals above that thickness. In this article the author discusses the amount of radium necessary for various exposures and thicknesses of steel and includes some very instructive radiographs taken by radium to prove the value. To take one single example: a radiograph of 5-inch steel at a distance of 30 inches would require 0.5 mg. of radium, while 6 inches of steel at the same distance would require over 1 gram if the exposure time were limited to fifteen hours.—*T. Leucutia*.

SPEAR, F. G. Summary of paper on the effect of split doses of gamma radiation on tissue cultures in vitro. *Brit. J. Radiol.*, Dec., 1931, 4, 680.

(a) *Effect on Mitosis*. Exposure of cultures to 100 mg. radium (element) at 0.5 cm. for $2\frac{1}{2}$ minutes causes a diminution in mitosis followed by a compensatory increase. Exposure for five minutes produces a similar effect.

Two irradiations, each of $2\frac{1}{2}$ minutes, give a different effect from a single exposure of five minutes. The effect further varies with alteration in the interval between the exposures. An interval of eighty minutes is more effective in bringing about a diminution in mitosis than an interval of 160 minutes.

(b) *Lethal Effect*. When cultures are exposed to 300 mg. radium at 0.5 cm. for six hours, a delayed lethal effect follows, and all the cultures die within sixteen days. In this case it is immaterial whether the dose is given all at once or in six fractions of one hour each at intervals of twenty-four hours.

(c) *Enhanced (Lethal) Effect from Splitting a Given Dose*. A similar delayed lethal effect can be obtained by a much shorter total irradiation if the dose is appropriately divided. By this

means the effect of a given irradiation may be greatly enhanced. Exposures to 300 mg. radium for $2\frac{1}{2}$ minutes at intervals of eighty minutes, until a total exposure of one hour has been given, produces a delayed lethal effect equivalent to that following a continuous irradiation of $4\frac{1}{2}$ hours.—*T. Leucutia*.

DOGNON, A., and PIFFAULT, C. L'action des rayons x sur les protozoaires et le problème de la sensibilisation. (The action of roentgen rays on protozoa and the problem of sensitization.) *J. de radiol. et d'électrol.*, Aug., 1931, 15, 442-446.

The authors constructed a special roentgen tube yielding a very large amount of radiation. This was obtained by reducing the distance of the anticathode from the window of the tube to only 25 mm. and by giving the anticathode a parallelepiped form, so that by simple rotation each of the four surfaces is successively exposed to the cathode beam. The rays emerge through two symmetric windows of 7 mm. diameter each. With 15 ma. and 16,500 volts (10 micron aluminum window, tungsten anticathode) a radiation of 1350 r per second is obtained. This destroys the ascaris egg in less than a second and produces a complete sterilization of a *B. pyocyaneus* culture in five seconds.

By making use of this tube, the authors were able to produce death of protozoa (paramecia) within normal conditions. The dose leading to immediate death was 500,000 r, whereas half of this dose produced no visible effect, the divisions continuing normally. Various toxic solutions led to shortening of the time of death (in some instances from 3 to 1) due, no doubt, to increase in the cellular sensitivity. Other solutions (resorcin, sodium hyposulphite), even in toxic concentration, failed to influence the time of death or counteracted the effect of the previous solutions, thus acting as desensitizers.—*T. Leucutia*.

SOUTTAR, H. S. On fields of radiation from radon seeds. *Brit. J. Radiol.*, Dec., 1931, 4, 681-689.

The problem which the author proposes to solve is that of producing a uniform field of radiation in which the cancer cells will be destroyed while the tissue cells are not affected. He uses radon seeds and by means of a special apparatus places them so as to obtain a uniform radiation on the area treated. For this purpose

he adopted a mathematical formula permitting the calculation of a continuous distribution of the radiation throughout a sphere and throughout a circular ring. Curves of constant radiation were drawn. To give one example, for the treatment of carcinoma of the cervix a ring pessary is formed with a thick body of rubber and a core consisting of a gold or platinum tube. The circular core contains a suitable amount of radium or its emanation which is doubly screened by the gold or platinum tube and by the rubber which surrounds it. Such a pessary can be easily placed in the upper part of the vagina so that it encircles the cervix of the uterus. In this manner the cervix, as well as the whole contents of the pelvis, is subjected to a radiation of remarkable uniformity sufficient to destroy all secondary deposits in the lymphatic glands.

It must be mentioned, however, that inasmuch as the procedure applies mathematical analysis to clinical problems, the whole question of absorption and secondary radiation is not considered. The author is dealing solely with the question of getting a flat radiation from a theoretical distribution. As the author states, his purpose was to put forward simple examples which may be suggestive to his surgical colleagues and may perhaps stimulate the interest of physicians in one aspect of a fascinating and important problem.—*T. Leucutia*.

MAYNEORD, W. V. The measurement in "r." units of the gamma rays from radium. *Brit. J. Radiol.*, Dec., 1931, 4, 693-710.

Summary. The paper discusses the physical aspects of the problem of dosage in radium therapy. Various units are discussed and reasons given for the choice of the r unit. Experimental arrangements are described, including a small ionization chamber suitable for measurements in the vicinity of a radium needle containing a few milligrams of radium element. The apparatus is calibrated in r by subjecting the chamber to a beam of hard roentgen rays, which is simultaneously measured by means of a second thimble chamber. The distribution of intensity around a 5 milligram needle is mapped out. The intensities in r/mg/hr. are measured and found to be in agreement with experiments by Glasser. Using probable data, the intensity of radiation at definite distances from a radioactive source are calculated and shown to agree with the experimental results. The relationship

between the international r and the Solomon R is calculated, and it is shown that $1 \text{ r/sec} = 1.65 \text{ R}$. This value is in good agreement with experimental results. The "unit skin dose" is of the order of 1,800 r for hard γ rays. The Mallet D unit and U.S.D. of Martin and Quimby are discussed and shown to be probably of the order of 117 r and 1,400 r respectively.—*T. Leucutia*.

STOENESCO, P., and CRACIUN, E.-C. Sur la présence des rayons secondaires dans l'organisme au cours de la radiothérapie profonde. (On the presence of secondary rays in the organism during the course of deep radiotherapy.) *Compt. rend. Soc. de biol.*, Oct. 16, 1931, 108, 325-326.

The authors placed a fluoroscopic screen in the abdomen of a dog during roentgen irradiation of the thorax, the remaining part of the animal being covered with lead, and found that there was a fluorescence of the screen. This indicates that secondary radiation is produced no matter how well the protection is applied. The same degree of impression was observed whether the screen was placed below or above the liver. It is concluded that the liver is always submitted to a certain action of the roentgen rays during irradiation of the thorax.—*T. Leucutia*.

SOLOMON, ISEK. Nouvelles recherches ionométriques. (New ionometric researches.) *J. de radiol. et d'électrol.*, Aug., 1931, 15, 432-441.

This article deals with the present status of ionometry in medical radiology and with the more recent researches of the author on the subject.

I. The ionometers may be generally divided into two groups: (1) the so-called variable potential ionometers in which the apparatus are charged to a certain potential and the discharge due to the ionizing action of roentgen, gamma and ultraviolet rays is estimated by the drop of potential as read on the graduated scale of the apparatus, and (2) the so-called constant potential ionometers in which the potential remains constant and the ionizing action of the radiations is measured by the intensity of the current as read on the graduated scale. The first comprise essentially an electroscope, an ionization chamber and a connecting cable. They have the great advantage that they permit a direct reading of the applied dose. However, the insulation which must always be ab-

solute constitutes one of the most delicate problems. The amber, sulphur and ceresin which are generally used unfortunately become feeble conductors during the action of the rays, producing an error occasionally as high as 30 per cent. By taking the necessary precautions (surrounding the tube and the instrument with lead, exposing only the ionization chamber to radiation, etc.), one may obviate this error. In connection with this the author describes his new charging device which is now added to the Solomon ionometer.

In the constant potential ionometers, the intensity of the current is measured, the apparatus thus functioning as intensimeters. The total dose is then calculated by multiplying the intensity by the time of exposure. Inasmuch as the intensity of the ionization current is very weak, various appliances are used for amplifying it, as, for example (a) filling of the ionization chamber with a heavy gas (xenon in the chamber of Dauvillier), or (b) intercalating relay bulb amplifiers as practiced chiefly in Germany (Siemens). One must place in a group apart certain ionometers such as the mecapien, the ionometer of Hammer, etc., which use a three-electrode bulb as a relay in the grid circuit. The principal advantage of all constant potential apparatus is that the insulation can be entirely neglected. Still by comparing the two types of ionometers from the practical clinical standpoint there can be no doubt that those of variable potential because of their simplicity and sturdy construction have the greater advantages.

II. The recent important work of Glasser and Küstner and their collaborators concerning the best type of ionization chamber demonstrated the necessity of using a small ionization chamber completely independent of the wave length. The material advocated by the different authors varies greatly (Friedrich, graphite coated horn; Holthusen, graphite coated paper; the author, graphite; Glasser, magnesium coated graphite; Glocker, silicated graphite; Küstner, graphite coated cellophan), but it has in all instances the common feature that it is of a low atomic weight, the effective atomic number (Glasser) being in the neighborhood of that of the air (7.6).

The ionization chamber of the author's ionometer was recently subjected to severe criticism, especially by Murdoch and Stahel, by Reiss and by Gunsett and Mlle Cohn. A re-

check by the author himself of the experimental results given in the above critical articles (by using a comparison with two large ionization chambers) has led to the conclusion that if one disregards the error of 10 per cent which must be considered normal, the variation in the figures must be attributed chiefly to the fact that (a) part of the cable was included in the field of the ionization and (b) the ionization chamber was not centered properly, leading to the off-focus radiation of Taylor. By correcting these factors, the ionization chamber appeared from a practical standpoint independent of the wave length.

III. The Second International Congress of Radiology, Stockholm, in taking the electrostatic unit as the quantitometric unit of x-radiation made the error of defining this unit on the basis of the ionization of the air. Various experiments since then have proved that this ionization is difficult to obtain. Especially two factors are of paramount importance during the measurement: (1) variation of the results with change in the form and position of the diaphragm (as proved by Failla), and (2) distortion of the electric field with change of the form, position and charge of the electrodes (as proved by Schechtmann). To overcome the errors resulting from these factors Taylor of the Bureau of Standards of Washington advocates for standardization purposes the use of the zero method which is recommended also by Dauvillier, Laborde and Saget.

The author, by taking into consideration the above factors, has re-checked the value of the r (as measured on his ionometer) and compared it with the International r , first by using the zero method (with the Dolezalek quadrant electrometer and then with the Lindemann electrometer) and second, by connecting a large ionization chamber directly to his own electroscope. It was found that in both instances the ratio $r:r$ was 2.2, which therefore must be considered as the true value of the ratio of these units.

Until an international congress will definitely establish the criteria under which the large ionization chamber may be used for standardizing purposes, the author proceeds with his ionometer as follows: The standardization into r is made by means of a radium source. The independence of the wave length of the ionization chamber is then determined by means of comparison with a large ionization chamber (which

was constructed at the author's directions by the Compagnie Générale de Radiologie). The constancy of the ionization chamber is checked from time to time by using the so-called "ionometric control" with uranium oxide condenser (for its description, see abstract, this Journal, 1931, 25, 574).

IV. The ionometer may be used with certain reservations also for the measurement of the gamma and ultraviolet rays. It must be mentioned, however, that the value of these measurements is only approximate.—*T. Leucutia*.

POITTEVIN. Générateur "Tripharix." ("Tripharix" generator.) *Bull. et mém. Soc. de radiol. méd. de France*, Nov., 1931, 19, 458-464.

The Compagnie Générale de Radiologie of France has constructed a new roentgen-ray generating apparatus utilizing the principle of three-phase current with six kenotron tube rectification. The machine which is called "Tripharix" yields a current of from 40 to 140 kv. and from 0 to 10 ma. for roentgenoscopy and from 40 to 140 kv. and from 0 to 2,000 ma. for roentgenography.

The various parts as well as the control cabinet are described in detail. A very accurate timer is used which permits the cutting down of the exposure to 6/1000 of a second.—*T. Leucutia*.

SIMON, G. Rationalisation of x-ray exposures. *Brit. J. Radiol.*, Jan., 1932, 5, 65-73.

Summary. Exposures are recorded at the present time in terms of kv. peak, milliamperes and time (distance, and whether screens or Potter-Bucky is used). This is unsatisfactory in practice, for three main reasons: (1) difficulties of measurement, especially for very short exposures of high intensity; (2) insufficiency of data, as wave-form affects the significance of the kilovolt (peak) measurements, while the tube factor must be included; (3) lack of a photographic standard of speed.

Conclusions. Some of the present difficulties might be solved: (1) by giving up the measurement of kv. peak and substituting for it a unit of "radiographically effective kilovolts," obtained by measuring on one's own set the number of milliamperes-seconds required to match a certain standard. The standard might be based on the kilovolts of a constant potential set, or a four- or six-valve set. Alternatively to work in terms of half-value absorption in, e.g.,

Al; (2) it is best to measure milliamperes-seconds and time, in the case of very rapid exposures, rather than measure milliamperes directly; (3) the setting up of a photographic standard of speed, both for films and films when used with screens. It might be possible and convenient to calibrate this in "I" units at a certain radiographically effective kilovolts, to produce a certain blackening.—*T. Leucutia.*

WITKA, W. A., and DMOCHOWSKY, W. W. Eine neue Methode zur Messung der Spannung an der Röntgenröhre. (A new method for the measurement of the tension of roentgen tubes.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1932, 45, 78-91.

This is a very technical article dealing with the Hefeli method for the measurement of the tension of roentgen apparatus. The method consists briefly in the intercalation of two condensers, the tension being estimated from the intensity of the current which flows through the wire connecting the condensers. It was found that by using a ballistic milliammeter and an accurate timer, the method can be used advantageously for the measurement of the tension in alternating currents.—*T. Leucutia.*

MÜLLER, K. W. Ein neues Hochspannungsvoltmeter zur direkten Messung der Röhrenspannung für Diagnostik und Therapie. (A new high tension voltmeter for the direct measurement of the tube tension for diagnosis and therapy.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1932, 45, 207-210.

The author constructed a high tension voltmeter which is based on the principle that the electric charge of a high tension condenser is measured ballistically, the charge being proportional to the peak voltage. The instrument which is gauged in kilovolts has an error of only ± 1 per cent, and has proved of practical value in both diagnostic and therapeutic roentgen outfits. In the former, it permits the estimation of the voltage even in the shortest exposures, while in the latter it gives a constant control of the tube tension during the entire course of the treatment. A photograph of the instrument as well as several diagrams is included.—*T. Leucutia.*

JEANS, JAMES. What is radiation? *Brit. J. Radiol.*, Jan., 1932, 5, 21-38.

This article is the 14th Silvanus Thompson Memorial Lecture and deals in extenso with the various opinions on the nature of radiation. Thus the corpuscular and wave theories, the kinetic theory, the wave mechanics, the meaning of photons, electrons and protons and the electro-magnetic waves are discussed in a very lucid and masterly manner. The article is concluded with a very remarkable illustration of the futility of attempting to depict in words processes which do not admit of being depicted either in terms of words or of the ordinary concepts of physics. A single instance is cited. A hydrogen atom is generally represented by a system of waves (the electron) and a center of force (the nucleus) which affects the propagation of these waves and in fact directs it when no other forces are present. We can of course represent a second hydrogen atom in precisely the same way but if we want to represent two hydrogen atoms under one another's influence it is not enough to dump down two nuclei and two wave systems at the appropriate points of space. There is a new wave system to represent the pair of atoms but ordinary three-dimensional space is not enough to contain it. It requires six dimensions as we should actually expect if the wave system represents only our uncertainty as to the value of six quantities. If we now try to depict the transfer of energy which in fact is precisely the radiation in such a system we can readily see that a transfer needs six dimensions of space for its proper representation. When, as in a photograph or a picture, we try to force three dimensions into two, we create all sorts of inconsistencies, we see a mountain looking no bigger than a man; and a cloud no bigger than a man's hand. We must not be surprised if forcing six dimensions into three has similar results.—*T. Leucutia.*

MOPPETT, WARNFORD. A thermo-electric instrument for measuring total x-ray energy with a determination of the practical units. *Brit. J. Radiol.*, Feb., 1932, 5, 159-168.

This apparatus was designed with a view to measuring total energy distributions, particularly if the theory holds that biological effects depend on the disturbance of "key atoms" rather than total ionization. Roentgen energy is (almost) completely absorbed by a plate of bismuth, and the increase in temperature at a bismuth copper junction generates a potential which is measured with a galvanometer. On

this basis, an apparatus was constructed by the author, assuming that all absorbed energy by the instrument is converted into heat. The apparatus is described in lengthy detail and illustrated with a photograph and diagrams. Some very interesting conclusions were obtained concerning the value of the Solomon R and of the international r in measuring the roentgen-ray dosage.—*T. Leucutia.*

MOPPETT, WARNFORD. The variation of total x-ray energy with potential. *Brit. J. Radiol.*, March, 1932, 5, 250-251.

It is generally accepted that roentgen-ray energy varies as the square of the exciting potential. By making use of a thermo-electric instrument (see above abstract), the author checked up the value of this law over a range of hard radiations used for radiotherapy (90 to 150 kv.). The figures obtained confirmed the law. As most previous work has been carried out with soft radiation and an ionization chamber, this new observation with harder rays is of distinct value. To give an extreme example: if the potential is inadvertently doubled, the roentgen-ray energy would be increased by a factor of 4. As may be expected, the total energy varies directly as the milliamperage for the range covered (3, 6 and 9 ma.).—*T. Leucutia.*

SCHALL, W. E. A two-valve transformer unit for diagnosis and therapy. *Brit. J. Radiol.*, Dec., 1931, 4, 711-714.

The apparatus is a combination of the ordinary straight forward single valve unit with a split transformer circuit using two valves. Its purpose is to give reasonably high kilovoltage (up to 150) for therapy and high milliamperage (up to 250) for diagnosis. The diagrams of the construction are briefly discussed.—*T. Leucutia.*

REISNER, ALFRED. Erythemversuche mit Grenzstrahlung. (Erythema production experiments with borderline rays.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1932, 45, 74-77.

The borderline rays produce an erythema of wavy character similar to that obtained with other rays. The peak of the erythema lies at a point which is twice that of the hard roentgen rays. A large dose produces marked inflammation of the skin, reaching its peak within a few days and lasting for a long period. The early appearance of the reaction is similar to that of the ultraviolet erythema, whereas the protraction is more of the type observed with the

roentgen rays. Small doses produce rather pronounced pigmentation which is always more pronounced than that observed with roentgen and ultraviolet rays. An epilation was never observed. The individual sensitivity is quite marked. The same degree of erythema was observed, for example, with 2,600 and 1,400 r.

The following procedure is followed in the treatment with borderline rays. An individual dose of 250 r is administered first; eight days later the reaction is studied and the further treatment guided accordingly. The superficial dermatoses are treated, as a rule, with small doses, whereas in nevus vasculosus, warts, etc., rather large doses are used, being always careful to protect the surrounding skin with a thick zinc paste or simple covering with towels.—*T. Leucutia.*

JASSINSKY, ING. Spannungsabfall im rotierenden Gleichrichter. (The drop of tension with rotating rectifier.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1931, 44, 770-777.

The author describes a method which permits the determination with the aid of an oscillograph of the drop in tension in mechanical rectification. In contradistinction to Varga (see this Journal, 1930, 23, 124) who made an error in his measurements, he found that the drop of tension does not depend on the voltage and intensity of current but on the size of the gap between the segments or brushes and the arm of the rectifier. With soft wire brushes, which reduce the gap to a minimum, the drop in the potential was the least (1 to 1.5 kv.), whereas with the cast copper brushes, owing to the greater gap, the drop was considerably larger (9 to 10 kv.). It is advised therefore that during continuous operation of a mechanically rectified machine the brushes be repeatedly inspected and approximated to eliminate the drop in the voltage.—*T. Leucutia.*

FORSSELL, GÖSTA. Sweden's anticancer campaign. *Acta radiol.*, 1931, 13, 295-318.

Figures are given showing that cancer is constantly increasing in Sweden which means that the burden of caring for cancer patients becomes greater every year. Therefore it became necessary to establish as efficient and economical organization as possible for extending existing means of treatment and making them available to everyone. The anticancer campaign is carried on along two great main lines: practical

hospital treatment and research and instruction in regard to cancer, and its treatment. There has been an effort to fit the cancer campaign into the general medical and nursing work of the country and avoid isolation and consequent over-organization. The treatment of cancer has been incorporated in the country's public hospital system and is carried on and paid for on the same principles as every other special medical treatment. Organizations for dealing with the surgical and radiological treatment of cancer have been established within the public nursing system.

The surgical treatment of cancer is performed in the general and special surgical clinics.

Radiotherapy for cancer has been centralized to a much greater degree than surgical treatment. Radiotherapeutic wards have been developed at three large central hospitals in Stockholm, Lund and Gothenburg and enlarged into central radiotherapeutic clinics for these sections of the country. These are equipped with personnel and material for roentgen and radium treatment and cooperate closely with the surgical clinics. Practically all the cases requiring radium or combined radium and surgical treatment are sent to these three clinics. Roentgen departments have been established in 26 of Sweden's 104 public hospitals in charge of medical officers specially trained in roentgenology. Cases requiring roentgen or combined roentgen-surgical treatment are sent to these hospitals.

Sweden has no special organization for following up cancer patients. This work is in the hands of the general practitioners and the outpatient departments of the hospitals. Means for transporting the patients quickly to the central radiotherapeutic institutions and paying their traveling expenses are provided at the central radiotherapeutic clinics. There are special departments at these clinics for controlling the treatment and looking after the patients during and after treatment, as well as social service workers and a public organization for statistical control of radiotherapy for cancer. Unfortunately no nursing service is provided for patients who are too far advanced to be given surgical or roentgen therapy. An organization for the care of these patients must be established.

Research in the radiotherapy of cancer is chiefly confined to the special radiotherapeutic

clinics. The universities have arranged for the teaching of radiotherapy by organizing courses of instruction and by training radiologists and nurses at the special radiotherapeutic clinics of the universities.—*Audrey G. Morgan.*

HOLFELDER, HANS. Comparison of medical, surgical, and radiological conceptions in relation of the treatment of disease. *Brit. J. Radiol.*, Jan., 1932, 5, 39-56.

This article represents the 12th Mackenzie Davidson Memorial Lecture. As the title indicates, the author considers the relative contribution of the medical, surgical and radiological man to the welfare of the patient, giving in a unique and very convincing way his conceptions of the status of these three men in the hospital. Thus he states: Everybody admires the skill of the surgeon, he is the great hero of the hospital, he is the most active personality, he is not the man of hesitation but of quick action who is always accustomed to see quick and prompt results. The internist, in contradistinction, focuses his attention upon every small symptom and sign, he is not a very quick acting man but his conceptions are much more contemplative. He observes the diseased patient very critically by means of very sensitive methods, therefore he is never satisfied with the diagnosis drawn from the synthesis of only symptoms of the disease but tries always to add other features of the special case in order to assure or to correct his first diagnosis. The roentgenologist, until now, was considered as merely a child but the child has meanwhile grown to manhood, having inherited the best gifts of its parents. The parents therefore should realize that the child now deserves an autonomous place next to them, equal in rank and right. For this reason the author advises that especially in radiation therapy, separate sections be established in the hospital under the direct leadership of the roentgenologist. Radiation therapy has become an essential part of the clinical method and requires urgently all clinical facilities. The University Roentgen Institute of Frankfurt, for example, takes full charge of its own ward with 50 beds. It is also very important that the actual treatment be carried out by competent roentgenologists. A careful planning out and application of every single roentgen-ray beam is one of the supreme and most important duties of the modern radiologist and determines the result of the

therapy just as the exact wielding of the knife determines the result of surgical operation.—*T. Leucutia.*

MOTTRAM, J. C. Some blood examinations of x-ray workers. *Brit. J. Radiol.*, Feb., 1932, 5, 156-158.

The author examined the blood picture of 30 radiologists and checked the findings against those of 26 hospital workers not exposed to roentgen rays. The blood counts are included in the form of a table. It was concluded, as a whole, that the blood of the roentgen-ray workers had not been affected by their occupation. However, in the control group the total red cells showed a rather high count, in the region of 7,000,000 in 7 cases. If these are deducted from the table, the average red count of the roentgen-ray workers appears higher as compared with the rest of the controls. This shift to the high side has been described by other observers as the earliest change in the blood of roentgen-ray workers, suggesting stimulation of the formation of the red cells. The distribution in white cells showed nothing in particular except in one case in which the count was as low as 3,000. This case will be observed further.—*T. Leucutia.*

ANDERSON, B. W. The use of x-rays in the study of pearls. *Brit. J. Radiol.*, Jan., 1932, 5, 57-64.

This article deals with the x-ray analysis of cultured and genuine pearls, giving a brief description of the methods which are used and of the apparatus necessary for the examination. A plate is included illustrating patterns of pearls and of the calcite and aragonite which are the two calcium carbonate forms accounting for approximately 92 per cent of the pearls (the remainder consisting mainly of the protein conchyolin and water). The method is of value also in certain gem stones forming a sort of a final court of appeal which takes the place of the destructive methods of chemical analysis.—*T. Leucutia.*

WALMSLEY, H. P. A cabinet for the storage of radium needles. *Brit. J. Radiol.*, Nov., 1931, 4, 608-610.

This article is a description of a cabinet constructed for the Manchester Radium Institute for storing radium needles. The cabinet is so devised that a stock of 700 needles containing approximately 2 grams of radium is stored. The

cabinet consists of 20 drawers, each $16\frac{1}{2}$ inches long and $1\frac{1}{2}$ inches square in cross section. They are arranged in five rows of four and are carried in compartments in a gunmetal casting of $\frac{1}{8}$ inch in wall thickness. Each drawer is filled to the top with lead, with the exception of a central wedge-shaped cavity $2\frac{1}{2}$ inches long at the bottom, in which a loose lead block containing the needles is placed. The manner of drilling the loose blocks depends on the size of the needles they are to hold. Diagrams are included to show the design. The advantage of the cabinet is, in addition to the protection it affords, that it takes only ten to fifteen minutes to check the contents.—*T. Leucutia.*

HIRSCHBERG, F. Le wagon radiologique des chemins de fer du Nord. (Radiologic car of the Northern Railway.) *J. de radiol. et d'électrol.*, Aug., 1931, 15, 451-454.

Since tuberculosis has lately made great ravages among the employees of the Northern Railway of France, the Company constructed an ambulatory roentgen-ray division which performs periodic examinations within the territory of the railway. The plans of the two pullman cars, arranged for this purpose, are discussed and illustrated with diagrams and photographs. From November, 1930, to June 1931, 1,322 examinations were made, the cars having travelled more than 1,400 kilometers. The arrangement has proved very satisfactory.—*T. Leucutia.*

BARCLAY, A. E. Der normale Schlingmechanismus. (The normal mechanism of swallowing.) *Acta radiol.*, May 15, 1932, 13, 91-109.

The author discusses the normal mechanism of swallowing. He holds that the bolus is carried from the back of the tongue to the level of the clavicle largely by negative pressure. The negative pressure in the pharynx is brought about by the combined action of raising the larynx and a backward movement of the tongue so that the pharyngeal space is completely obliterated for a fraction of a second. With mouth, nose and larynx closed, the re-opening of the pharynx produces a negative pressure that is largely responsible for the act of swallowing. Except for fluids gravity plays a very minor part in normal swallowing. The larynx is cut off during the act of swallowing by the laryngeal pharynx being dragged up behind the larynx into contact with the epiglott-

tis, probably about a quarter of an inch below the tip of the epiglottis.

The phases in the process of swallowing are: (1) The mouth and nose are closed. (2) The larynx is raised and closed and its upper part is obliterated by the back of the tongue. (3) The pharyngeal space is obliterated by raising the larynx and retracting the tongue. The posterior wall of the pharynx does not come forward; the pharynx is not constricted but is compressed from before backward against the vertebrae. (4) The pharynx is opened and with the other three openings closed a negative pressure is brought about by lowering the larynx and a forward movement of the tongue. (5) During this movement the laryngeal pharynx still remains high up in close contact with the epiglottis. Its orifice is wide open. (6) The bolus slips over the back of the tongue. (7) Food is sucked into the open mouth of the laryngeal pharynx which, as the bolus passes into it, drops from the epiglottis down to its normal position, opening up the larynx after the bolus has passed. (8) The food is probably carried some distance down the esophagus by suction.—*Audrey G. Morgan.*

WUCHERPFENNIG, V. Zur Verteilung der Roentgenstrahlen in der Haut. (The distribution of roentgen rays in the skin.) *Strahlentherapie*, 1931, 42, 544-550.

Since no reliable determinations of the distribution of roentgen rays within the skin by means of small ionization chambers have been reported, the author calculates this distribution, using absorption values obtained in water and aluminum by Allen, Richtmyer and others. From the absorption in aluminum and water the absorption in tissue is obtained. Those points in the tissue which obtain 90 per cent, 80 per cent, etc., of the surface energy are called "relative depths" and they are illustrated on a schematic diagram of the skin for various half-value layers of aluminum. The accuracy of this method is limited and direct measurements of the intensity distribution within the skin are highly desirable.—*Otto Glasser.*

PONZIO, MARIO. L'Istituto Radiologico Mauriziano di Torino. (The Mauriziano Radiological Institute at Turin.) *Radiol. med.*, Feb., 1932, 19, 166-173.

This new radiological institute was opened on August 31, 1931. It is equipped with the most thoroughly modern apparatus for roentgen

diagnosis and roentgen and radium treatment. It also has a laboratory for physical and biological research, a section for physiotherapy and a good roentgen library. The apparatus in use and the arrangement of the rooms are described in detail and illustrated.—*Audrey G. Morgan.*

VANONI, ENZO PUGNO. La protezione contro il pericolo da elettricità e da raggi in radiologia. (Protection against electricity and rays in radiology.) *Radiol. med.*, March, 1932, 19, 328-343.

The International Congress of Radiology in Paris in 1931 adopted the following rules as international norms for protection. Of course they are only suggestions for adoption by the different countries.

Workers with roentgen rays should not work more than seven hours a day and not more than five days a week and the free days should be passed as far as possible out of doors. They should have not less than four weeks' vacation a year, preferably consecutive. On entrance into the service and thereafter twice a year they should have a systematic physical examination and blood examination.

The roentgen-ray section should not be below ground level. All rooms, including the dark room, should be provided with windows giving plenty of light and air. All should be provided with adequate aspirating ventilators, capable of renewing the air not less than ten times an hour. All the rooms should have light colored walls. The best temperature for a roentgen room is 18° C. All rooms should be large enough for convenient installation of the apparatus—the minimum area should be 25 square meters for the roentgen room and 10 square meters for the dark room. The height of the room should not be less than 3.5 meters. If possible the apparatus for generating the high tension current should be kept in a separate room from the tube.

Roentgen-ray workers should not expose themselves unnecessarily to the direct action of the rays; they should stay as far away from the tube as possible. The tube should be surrounded as completely as possible by a protecting material equivalent to a certain thickness of lead; the thickness necessary for different strengths of current is given. In diagnostic work the operator should be protected from diffuse rays by a screen equivalent to 1 mm.

lead. In treatment the operator should preferably be outside the roentgen room behind a protective screen equivalent to 2 mm. lead. This thickness should be correspondingly increased if the protection of the tube is less than that specified above. Screen examinations should be carried out as rapidly as possible, with as small a field as possible and the lowest possible tension. Palpation with the hands should be limited as much as possible. The lead-glass of the fluorescent screen should have the same protection as indicated above for the tube. In diagnosis adequate protection should be provided for the operator against the diffuse radiation of the patient. The inspection windows in walls or screens should have protection as adequate as other parts of the wall or screen. Protective measures should be adopted against the possible omission of metallic filters in roentgen therapy. Gloves should have a protection equivalent to not less than $\frac{1}{2}$ mm. of lead, covering both the back of the hand and the palm and including the fingers and the wrist. Aprons should have a protection equivalent to 0.5 mm. lead.

To protect against electricity the pavement should be of isolating material, such as wood, rubber or linoleum. The high tension wires should be not less than 3 meters above the floor. They should be made of metal wires of considerable size or some other conductor which will not produce a corona effect. The connecting wires should be made in such a way as not to produce a corona effect. If possible the high tension circuit should be completely enclosed in conducting screens connected with the ground. If there is no special reason to the contrary the metal parts of the apparatus should be connected with the ground. Bipolar interruptors should be used which will interrupt both poles at once. When more than one apparatus is supplied by the same generator suitable deviators should be used. A kilovolt-meter should be installed for measuring the tension. Special precautions should be used if anesthetics are being used at the same time as roentgen rays.

The use of non-inflammable films is recommended. If inflammable films are used special precautions should be used, but it is difficult to give details because the laws for fire protection differ in different countries. Large amounts of films should be kept in separate buildings in isolated places.

To protect the hands against beta rays, ra-

dium should be handled with forceps with long handles and should be carried from one place to another in boxes protected on all sides with at least 1 mm. lead. All manipulations should be carried out as rapidly as possible. When not in use radium should be kept in a safe as far as possible from the personnel. The radium tubes should be placed in the safe in cells with lead walls varying in thickness for the amount of radium. The thicknesses for various amounts are given. The tubes should be mounted in a special place where the workers remain only while at work. To protect the body against penetrating gamma rays a screen should be used equivalent to not less than 2.5 mm. lead and the operator should not remain near the radium any longer than necessary. The room for measuring radium should be a separate one and the radium should be kept there only while it is being measured. Nurses and attendants should not remain where a patient is being treated with more than half a gram of radium. All work that is not specialized should be done by temporary workers who should not remain at it more than six months. Care should be taken in sending radium by mail. Small amounts should be protected with not less than 3 mm. lead. Large amounts should be carried by hand, suitably protected.

Persons using radiations should be protected against both beta and gamma rays. The emanations should be manipulated as far as possible while they are inactive. Any escape of emanations should be avoided and the place where they are used should be provided with an aspirator. If the emanations are apt to come into contact with the fingers thick rubber gloves should be used to prevent the formation of a deposit on the skin. The protective measures indicated above for salts of radium should also be used. The pumps should be in a separate building connected by tubes with the place where the radium solution is. The radium solution should be strongly screened to protect those who work near it. It is best to keep it in boxes lined with lead of the thickness given above for radium salts.

These rules are probably not final but the author recommends their adoption in Italy in place of the rules adopted there in 1925 which are insufficient.—*Audrey G. Morgan.*

DESJARDINS, ARTHUR U. The postgraduate and graduate teaching of radiology. *J. Am. M. Ass.*, March 19, 1932, 98, 933-936.

A well-considered scheme of instruction should provide for a short postgraduate course of a few weeks for physicians in general who wish to be informed of newer methods, as well as radiologists who wish to keep abreast of new developments. Opposition to this kind of course, based on the belief that it would encourage physicians to employ radiologic measures without sufficient preparation, is without adequate foundation in fact. Radiology as a specialty would benefit by such dissemination of knowledge as have other specialties.

A second or comprehensive graduate course for physicians who desire to qualify as specialists in radiology should be developed on broadest possible lines. A three year course should include first, a half year of concentrated training in anatomy, physiology, pathologic anatomy, and microscopic pathology, with which subjects radiologists cannot be too familiar. Next should follow a half year given to radiologic physics with both didactic lectures and laboratory exercises. The second year of the course should deal with diagnostic roentgenology. Under careful supervision the student should be required to perform all technical procedures and make interpretations. The third year should be given over to therapeutic radiology, including roentgen rays, radium and ultraviolet radiation with equal time devoted to roentgen-ray and radium therapy, although the latter has a narrower scope. Finally, each graduate student should be required to undertake a piece of research on some phase of diagnostic or therapeutic radiology and prepare a report or thesis based thereon.—*E. W. Hall.*

PANCOAST, HENRY K. Teaching of radiology to undergraduate students. *J. Am. M. Ass.*, March 19, 1932, 98, 938-943.

Undergraduates should be given instruction in radiology so that as internes and physicians they may be able to appreciate roentgenograms, understand the numerous references to radiology in literature, and know the value and limitations of radiology in its applications to various diseases and various medical specialties. They should be impressed with the importance of radiologic interpretation by competent and honest specialists to avoid their support and toleration of unscrupulous physicians and laymen who commercialize radiology.

Didactic instruction should be avoided except where necessary. However, a short didac-

tic course in physics should be the first part of the training. Anatomy, physiology and pathology should be taught in relation to roentgenography, incorporating roentgenologic demonstrations in the regular lectures. All preclinical as well as subsequent instruction should be under the direction of the professor of radiology. In the third and fourth years separate lectures and demonstrations are advisable with review of principles of the basic subjects. Small groups are preferable to large groups. Radiation therapy should be taught through the agency of cancer clinic groups.—*E. W. Hall.*

RUSS, SIDNEY. Nature of the action of radium and x rays upon malignant growths. *Lancet*, April 23, 1932, 1, 874-876.

The various theories of the nature of the action of gamma rays of radium and roentgen rays upon malignant growths are reviewed. Altogether the evidence seems to show that the action of these rays is partly a direct one and partly an indirect one. In an evaluation of the various actions of these radiations, bearing in mind their order of appearance in the scale of quality—how some of the vital functions of living tissues are put out of action by a quantity of radiation which has but a trifling action upon their other processes—perhaps the most important classes of action would be determined as: (1) Those which interfere with or disorganize the delicate processes involved in the division and maturing of cells; (2) those which determine the release into the tissues and into the circulation of the products of cells, normal as well as malignant, whose destruction is caused by the rays, and (3) those which produce changes not only in the content and production of the blood, but also in its power of dealing with infection.—*W. R. Brooksher, Jr.*

MEYER, HEINZ THEODOR. Über Wellenlängenabhängigkeit kelinier Ionisationskammern. (The wave length dependence of the small ionization chambers.) *Strahlentherapie*, 1931, 40, 576-589.

The author investigated the dependence upon wave length of a large series of thimble ionization chambers. Various substances (Si, Al₂O₃, MgO and BeO) were added to graphite chambers, and measurements of the ionization current in these chambers for rays of a half value layer of 0.15-2 mm. of copper were made. The percentage weight of the various sub-

stances which were added to the graphite in order to obtain ionization currents which were independent of the wave lengths, was determined. The results obtained permit drawing conclusions as to the accuracy of the Fricke-Glasser method of the small air chamber. The author finds that, strictly speaking, the important factor is not the effective atomic number, according to Fricke and Glasser, but the electron density in the chamber material. A large number of experiments, tables and curves proving these statements are given.—*Otto Glasser.*

BENNER, SVEN. On secondary β -rays from the surface of radium containers. *Acta radio.*, Sept. 30, 1931, 12, 401-412.

The secondary β -irradiation from different substances has been examined by means of an ionization chamber, using a magnetic field to deflect the β -rays. In agreement with other authors it is found that the secondary β -radiation, as a function of atomic weight, has a broad minimum, approximately between 26 and 50, the atomic weights of iron and tin. Its great importance in treatment is pointed out and a palladium alloy is proposed as a suitable material for radium needles. For other types of radium applicators nickel or rustless steel is recommended as secondary filters.—*Audrey G. Morgan.*

FAILLA, G., and HENSHAW, P. S. The relative biological effectiveness of x-rays and gamma rays. *Radiology*, July, 1931, 17, 1-43.

A direct method of measuring gamma rays in roentgens is described. In principle, it is the same as the one ordinarily used for standardization measurements with roentgen rays. With the method and apparatus used by the authors the gamma-ray emission of 1 gram of radium was found to be 36 r/min. at a distance of 1 cm. Experiments are described which make possible the direct comparison of biological effects produced by roentgen and gamma rays in five different tissues. The experimental results show that the quantity of radiation required to produce a certain degree of effect in a given tissue depends on the quality of the radiation. Therefore, in radiation therapy the radiosensitivity of all tissues in the irradiated volume should be known for each quality of radiation employed.—*J. D. Camp.*

TAYLOR, LAURISTON S. International comparison of x-ray standards. *Radiology*, Jan., 1932, 18, 99-114.

Direct comparisons between the roentgen ionization standards of the United States, England, Germany, and France, are described. The small guarded field ionization chamber was used as the working standard and transported to the several laboratories. Careful check of the instrument calibration at each laboratory showed no change due to transportation. Complete corrections were made for air absorption, differences in current measurements, and differences between chamber diaphragms. The final agreement between the United States, English, and German standards was ± 0.5 per cent. The ratio between the international roentgen and Solomon's unit for hard radiation (half-value larger than 0.75 mm. Cu) was 2.29. As a result of diaphragm discrepancies found in England, a study of diaphragm measurements was made. It was found that lead diaphragms tended to warp with age, rendering difficult an accurate determination of their area. Plug gauge and micrometer microscope measurements were averaged for the final results.—*Ellsworth Johnson.*

MOTTRAM, J. C., and EIDINOW, ALBERT. On the effect of anaemia on the reactions of the skin and of tumours to radium exposure. *Brit. J. Surg.*, Jan., 1932, 19, 481-487.

An effort was made to study variations in skin reactions from a radium plaque produced in rats following an artificially induced anemia. A standard erythema dose was applied to control animals and to a group in which 1 to 5 c.c. of blood had been removed from the heart. The skin reactions produced by both beta and gamma radiation were definitely less severe in the anemic animals.

A second series of experiments was carried out by using rats inoculated with small pieces of Jensen's rat sarcoma in both flanks. One tumor was treated with beta rays before the bleeding process and the other afterwards, using the same dose each time. During the period of observation, it was noted that the tumors treated after the induction of anemia grew more rapidly than the controls. The authors conclude that tumors in anemic individuals do not respond well to irradiation and advise that a special effort be made to combat

anemia in cancer patients before treatment is administered.—*C. L. Martin.*

LAURITSEN, C. C. Spectrum of the radiation from a high potential x-ray tube. *Radiology*, July, 1931, 17, 131-135.

A spectrograph of the Seemann type was constructed for the purpose of investigating the radiation from the high potential roentgen tube at the California Institute of Technology. A typical spectrogram obtained with 600 kv. on the tube is presented. The photometer record shows a continuous spectrum with its maximum intensity to about 200 kv. and a short wave length limit in the neighborhood of 600 kv. The range covered is roughly from 100 to 20 x-units. It is proposed to use the apparatus for determining absorption coefficients by photographing the spectrum of radiation which has passed through an absorbing screen. No anomalies of any kind have been observed so far.—*J. D. Camp.*

CLARK, G. L., and FITCH, K. R. Chemical effects of x-rays upon some aromatic colors and dyes. *Radiology*, August, 1931, 17, 285-293.

A large number of aromatic colors and dyes were exposed to roentgen rays under the same condition of irradiation, to determine, if possible, some of the general types of structure giving good visible color changes. Some of those showing the most promise from the point of view of stability and degree of color change are the triphenyl methane, alizarin, thiazine, and indigo types. Experiments were started upon simple molecules with but one or two reactive groups and were carried through to more complicated structures.

Substituent non-metallic groups may change the susceptibility of the labile bond in a simple aromatic structure toward roentgen exposure. Metallic salts and complexes of an aromatic color may give color changes upon exposure to roentgen rays much different from that of the parent dye, thus vastly increasing the number of possibilities of these changes.

Any type of color changes desired, such as color increases, decreases, etc., can be obtained by proper selection of the colors. From the known chemical and physical properties of these compounds, many roentgen-ray color changes can be predicted in advance.

The magnitude of the field is such that in all

probability the color most suitable as an intensity indicator has not yet been found. The roentgen ray in particular and radiation in general furnish one of the most sensitive tools known for the examination of complicated reactions.—*J. D. Camp.*

TAYLOR, LAURISTON S. Accurate measurement of small electric charges by a null method. *Radiology*, August, 1931, 17, 294-303.

In the use of an electrostatic system for measuring charges and currents, it is necessary to know the electrostatic capacity of the system. For small capacities the error in this measurement may easily be 1 per cent. There is here described a new method for calibrating a null system in such a manner that the capacity of the leads does not enter and which, therefore, permits a reduction in the calibration error to one-tenth. When a system is once calibrated in the manner described, any unknown capacity whatever may be added to the leads without affecting the measurement of the desired quantities. Expressions are given for the sensitivity of the system in terms of readily measured quantities. Applications to the measurements of current, charge, and capacity are discussed.—*J. D. Camp.*

PROFITLICH, P. Über den Spannungsverlust im Scheibengleichrichter. (On the loss of tension in disc rectifier.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1931, 43, 498-501.

The author, by making use of Küstner's ionization apparatus, determined the drop in the high tension voltage caused by disc rectification, and found that the increase in the secondary voltage (40, 50, 60 and 70 kv. max.) had no effect when the milliamperage remained constant, the drop in the voltage being always the same (7 kv.); whereas the increase in the milliamperage (1, 5, 15, 30 and 60 ma.) with constant high tension voltage produced a decrease in the loss of the rectification voltage. This latter is contrary to what one would expect and is the result no doubt of the decrease in the resistance due to the transformation of the sparks at the rectifying brushes into arc flames.—*T. Leucutia.*

WEBER, E., and RUSSO, C. Über die Abhängigkeit der Expositionszeit von der Spannung. (On the dependence of the exposure time

on the tension.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1931, 43, 226-231.

The present article was written in 1927 but because of the loss of interest in the subject it was not published until now. The stimulus for its present publication was furnished by a recent communication of Profitlich stating that the fourth power law does not always apply to the calculation of the exposure time. The authors, after minute investigations of the dependence of the exposure time on the variation of the voltage, have found that the following formula is of value:

$$t_2' = t_1' \frac{ma_1 kv_1 x}{ma_2 kv_2 x}$$

in which t_1' is the known time of exposure, t_2' the time of exposure to be determined, ma_1 the milliamperage of the current in the known exposure time, ma_2 the milliamperage of the current in the exposure time to be determined, kv_1 the tension of the tube in kilovolts in the known exposure time, kv_2 the tension of the tube in kilovolts in the exposure time to be determined and x the power exponent. This latter is determined by making two roentgenograms of the same object under identical conditions with two extreme voltages, being careful to obtain an identical optimum blackening of the soft parts on the film. The power exponent, in other words, the power to which the voltage has to be raised, is then figured as follows:

$$x = \frac{\log t_2 - \log t_1}{\log kv_1 - \log kv_2}$$

in which t_1 is the exposure time in seconds in the first roentgenogram, t_2 the exposure time in seconds in the second roentgenogram, kv_1 the tension of the tube in kilovolts of the first roentgenogram, and kv_2 the tension of the tube in kilovolts of the second roentgenogram.

The formula can be used: (1) for the calculation of the exposure time in case the milliamperage or the voltage is changed, everything else remaining the same, and (2) for the calculation of the required load of the apparatus and tube in a given exposure time and object type.—*T. Leucutia*.

DOGNON, A., and MASSA, J. La technique et l'action biologique des rayons X de très grande longueur d'onde. (The technique and biologic action of roentgen rays of very long wave length). *J. de radiol. et d'électrol.*, Jan., 1931, 15, 22-32.

The authors, in experimenting with the Dauvillier tube for more than a year, found that this tube has certain disadvantages which makes a regular service impracticable. One of these is that the cellophan window often breaks due to the excessive heat produced by the bombardment of the electrons (or of the ions of the residual gas). Other disadvantages are in connection with the mounting of the tube, the change of filters and the pumping system.

The authors have made several modifications which render the use of the tube more simple and practicable. These modifications which apply chiefly to the construction of the tube, to the pumping system and to the source of energization (constant tension generator) are described in detail and illustrated with diagrams and photographs. The breaking down of the window was eliminated by supplying the lower part of the tube with a cooling device.

After discussing the best method of measurement, the dependence of the output of the tube on the voltage and thickness of the cellophan window, the decrease of the intensity with increasing distance, the action on the epidermis, the threshold erythema, the question of penetration and the effect of superimposition of the doses, the authors arrive at the conclusion that although the recent modifications have made the application of roentgen rays of very long wave length a rather simple procedure, the therapeutic value still remains limited. The results obtained are as yet far from satisfactory, despite the fact that two good qualities of the rays must be recognized: (1) enormous doses may be administered over the epidermis without provoking the least permanent injury and (2) the intensity and extremely long duration of the erythema provoked, as well as the possibility of re-application permit their use for long periods.—*T. Leucutia*.

CHANTRAINE, HEINRICH, and PROFITLICH, PAUL. Über gleichgerichteten Wechselstrom, gleichgerichteten Drehstrom und reine Gleichspannung. (On the rectified alternating current, rectified rotating current and true constant tension.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1931, 43, 746-757.

The authors compared the radiation output of the valve rectified alternating and rotating current machines with that of the constant tension machine by making use chiefly of the

photometric and, in a few instances, of the ionometric method. The radiation was filtered with 7 mm. Al which corresponds to 7 cm. water thickness or the thorax of a medium developed individual.

It was found that by using 38 kv. with constant milliamperage and 7 mm. Al filter, an exposure 3.5 times longer was required with the rectified alternating current to obtain the same degree of blackening of the film than with a constant tension, this indicating that the radiation output at 38 kv. constant tension was 3.5 times greater than at 38 kv. max. rectified alternating current. At the same time, the radiation produced by the constant tension was somewhat harder, the rays obtained with 38 kv. being equal to the rays produced by 39 kv. max. rectified alternating current. By reducing the 39 kv. max. (which yields with 7 mm. Al an amount of radiation 33 per cent higher than at 38 kv. max.) to 38 kv. max. and by deducting the 33 per cent increase in the radiation output due to the higher voltage, the figure of 2.6 is obtained, that is, the increase in the radiation output of the constant tension machine, as compared with the rectified alternating current machine, will drop from 3.5 to 2.6 (at 38 kv.). If the comparison is made at a higher voltage, as, for example, 700 kv., the increase in the radiation output of the constant tension machine will be only 2.1 times greater. This figure, by again deducting the difference resulting from the equalization of the hardness of the rays (70 kv. max. of the rectified alternating current corresponding to 64 kv. constant tension with a difference of 40 per cent in the output) is further reduced to 1.54. Finally, if one takes into consideration that the constant tension generally yields an energy 1.4 times greater than the rectified alternating current, an improvement of only 10 per cent is obtained.

In comparing the rectified rotating current with the constant tension current it was found that the six phase current fairly resembles the constant tension current, whereas the three phase current (which is the one used in several machines) yields after eliminating all sources of error an improvement which is only half of that of the constant tension current. In connection with this, the author discusses the value of the Philips condenser apparatus (which, as is known, is a rectified rotating current machine) for roentgenography of the chest.

The amount of radiation delivered to the skin of the back in case of roentgenography of the lung with true constant tension is 0.9 to 1.1 r.

With rectified alternating current, the output of the gas containing tubes is nearly 100 times greater than the output of the gas free tubes, assuming that the same kind of radiation with identical milliamperage and 7 mm. Al filter was used. This increase is due to the flatter and broader peak of the tension with gas containing tube.—*T. Leucutia*.

SIEVERT, ROLF M., and OLSSON, ERNST. Zur Bestimmung des Mesothor und Radiothorgehalts von eingekapselten Radiumpräparaten. (Determining the mesothorium and radiothorium content of encapsulated radium preparations.) *Acta radiol.*, Apr. 15, 1931, 12, 121-134.

The authors describe experiments carried out with a gamma-ray absorption apparatus made on the principles described by Bothe in *Ztschr. f. Physik*, 1924, 24, 10. They discuss the possibility of determining whether radiothorium or mesothorium is contained in encapsulated preparations and show that this method, which is based on the variation of the radium equivalent with increasing lead filtration, is suitable for the following purposes: (1) determination of the proportion of mesothorium in freshly made radium-mesothorium preparations; (2) determination of the amounts of mesothorium and radiothorium present provided the proportion of radium is known, and in that case it is also possible to determine the approximate age of the preparation; (3) determination of the proportion of radium when the proportion of radiothorium to mesothorium is known from the age of the preparation.

A large number of preparations practically free of radioactive impurities were examined to determine the exact margin of error of the experiments. The curves for mesothorium and radiothorium respectively were obtained by measurements with mesothorium free of radiothorium and with pure radiothorium. With the aid of these curves the radium equivalent of any test specimen can be determined and the radium-equivalence of the radioactive impurities present can be calculated within a few per cent. The accuracy of the measurements is to a great extent dependent on the age of the preparations but as a general rule the method

is reliable for determining even considerable amounts of mesothorium and radiothorium.—*Audrey G. Morgan.*

SIEVERT, ROLF M. A new method for determining the intensity of γ - and x-ray irradiation. *Acta radiol.*, Apr. 15, 1931, 12, 190-199.

This is a preliminary announcement of a new method of measuring radium and roentgen radiation. It is possible by means of it to make accurate and simple measurements of the distribution of radiation in the human body without the necessity of installing delicate measuring instruments in the operating room. The method is based on the ionization effect in a chamber of large capacity relative to its air volume. A charged, closed chamber without connecting wires is exposed for a certain time to the radiation to be examined, and the consequent loss of potential is then determined by placing the chamber on an electrometer of comparatively low sensitiveness (a Wulf double-string instrument). Corrected by means of the calibration curve of the instrument, the deflection furnishes a relative measure of the intensity; when this is multiplied by a constant determined experimentally for each chamber, the result may be expressed in absolute units.

Two chambers have been examined, the smallest of which is a ball of very light material; it is made of magnesium and is 14 mm. in diameter. As this chamber proved very reliable, similar chambers are being made, the smallest of which are 12 mm. long and 5 mm. in diameter or 20 mm. long and 3 mm. in diameter. The latter type is provided with a sharp point for interstitial application like radium needles.

The author thinks the method very promising and will in the near future publish further detailed examinations.—*Audrey G. Morgan.*

REUTERWALL, O. The work of the Radiumhemmet's department for tumor pathology. *Acta radiol.*, 1932, 13, 395-403.

The cases referred to a special clinic are apt to be particularly difficult ones requiring the judgment of a clinical pathologist in their interpretation. The Radiumhemmet has had a pathological department since 1923 and the author reviews the work of this department. The work of the department includes microscopic diagnosis and prognosis, the scientific

analysis of material treated by irradiation and research in the fields of tumor and irradiation pathology. The department has two special tasks to accomplish: the refinement of diagnosis from specimens obtained by biopsy and the establishment of a basis for diagnosis in material treated by irradiation. The specimens obtained by biopsy are often almost infinitesimally small and diagnosis from them very difficult. Diagnosis is also very difficult from tissue that has been subjected to irradiation. The study that has been given to changes caused by irradiation has been an effort to determine their causes rather than to classify the varieties in the picture and determine their relation to the original growth.

One important fact brought out by the department is that electrocoagulated tissue can be used for microscopic diagnosis. They have been making a special study of cancers of the breast, and the so-called mastitis or fibroadenomas, carcinomas of the uterus and papillomatous tumors of the ovary.—*Audrey G. Morgan.*

VISCHIA, QUINTINO. Il trauma nella genesi dei tumori. (Trauma in the genesis of tumors.) *Radiol. med.*, June, 1932, 19, 551-557.

There is still active discussion in regard to the relationship between trauma and tumor, which is of great medicolegal importance. The author reviews the cases of tumor caused by trauma which have been reported in the literature and reports one of his own in which he thinks the tumor was caused by trauma.

The patient was a woman of twenty-seven who had always been well. She had had 4 pregnancies, one of them interrupted by abortion in the third month. The three children are living and well. Two years ago she fell from a height and struck on her left leg. She had pain in the upper third of the leg and redness and swelling of its anterior surface. She soon recovered but about a week before her admission to the hospital suffered another trauma in the same region, followed by pain and such great swelling that it was hard for her to walk. She had no fever and her Wassermann reaction was negative. There was a hard painful swelling of the anterolateral surface of the left leg. Roentgen examination in the anteroposterior and lateral directions showed an intensely opaque shadow about the size of a hen's egg involving the region of the lateral condyle of the tibia and all of the proxi-

mal epiphysis of the fibula. The head of the fibula showed a vertical fracture line. Roentgen examination of the thorax for metastases did not show any pathological condition.

As the patient refused operation the tumor was removed and the bone curetted but recurrence in the knee necessitated amputation. Histological examination showed that the tumor was a fibrosarcoma.

The author thinks the evidence was sufficient to show that the tumor was caused by the trauma. He does not discuss the possibility of a pre-existing tumor being awakened into activity by the trauma which is a prominent point in many of the discussions on this subject.—*Audrey G. Morgan.*

RÉMY-ROUX. Sur un cas de granulations calcaires sous-cutanées (contribution au pronostic). (A case of subcutaneous calcareous granulations; contribution to the prognosis.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1932, 20, 437-440.

The author recently had the opportunity of re-examining a girl whom he saw two years previously at which time roentgenograms demonstrated subcutaneous calcareous deposits in several parts of the body. Since then the condition has made a very rapid deterioration, the patient being at the present time in quite a precarious state. Calcareous deposits are demonstrated now in the subcutaneous tissue localized throughout the body and invading part of the muscles. The conclusion is reached that this condition is more serious than hitherto assumed. The progressive calcification which started in the subcutaneous tissues had led to a state of total invalidism as soon as the muscles became involved and at the present time the life of the patient is in danger.—*T. Leucutia.*

DOUMER, E. Traitement des radiodermes par l'acide elaïerinique. (Treatment of radiodermatitis by elaidic acid.) *Bull. et mém. Soc. de radiol. méd. de France*, Dec., 1931, 19, 498-502, also Jan., 1932, 20, 22.

The author two years ago published in the *Gazette des Hôpitaux* a short article calling attention to the method of treatment which he had proposed for radiodermatitis about twenty-five years ago. He received numerous letters endorsing the method and therefore in the light of these new documents he now re-describes the procedure. It consists in the use

of elaidic acid which is prepared from lamb fat and put on the market under the name of "lipol," being applied in the form of a salve. In case of acute radiodermatitis a healing is observed within a few months but in the chronic cases a more prolonged use is advisable. Two rather unusual cases in which good results were obtained are described in detail. The author also states that he himself developed a rather severe radiodermatitis which he treated in 1906 with lipol having obtained a good healing which has persisted since.

In the discussion which followed, Haret mentions that he used the preparation about two years ago for a chronic radiodermatitis with a deep ulcer of the right ring finger but that later an amputation had to be performed. More recently he applied it to an ulcer of the right index finger which has now persisted for about eight months. He observed some very good initial response but one month later the ulcer failed to entirely heal. He will continue its use, however.—*T. Leucutia.*

BARONI, V., and COMSIA, O. Influența clorurei de magneziu asupra evoluției sarcomului experimental. (Influence of magnesium chloride on the evolution of experimental sarcoma.) *Cluj. med.*, Nov., 1932, 13, 531-533.

It was observed since 1891 that very few cases of cancer occurred in Egypt. This unique phenomenon was explained on the ground that the soil of Egypt is very rich in magnesium salts which have an inhibiting effect on the development of cancer.

Several experiments were made recently in testing the effect of magnesium preparations on the growth of cancer. The authors experimented with a series of sarcomas in rats and arrived at the following conclusions: (1) Magnesium chloride has an inhibiting action on the growth of Jensen's sarcoma; (2) the healing effect of this salt is the greater, the less the virulence of the tumor; (3) large doses nearing the limit of toxicity are not as efficacious as smaller doses; (4) the best route of administration is the intraperitoneal one; (5) a preliminary magnesiumization of the animals increases the percentage of healings; (6) animals treated with insufficient doses of magnesium present an excessive growth of the tumor.—*T. Leucutia.*

BARONI, V., and COMSIA, O. Influența clorurei de amoniu asupra evoluției sarcomului experimental. (Influence of ammonium chlo-

ride on the evolution of experimental sarcoma.) *Cluj. med.*, Dec., 1932, 13, 590-592.

In a second series of experiments the authors tested the effect of ammonium chloride on the sarcoma of rats, arriving at the following conclusions: By injecting ammonium chloride intraperitoneally into rats with Jensen's sarcoma of average virulence a complete disappearance of the tumor is obtained in 60 per cent. It is probable that the slow action of the salt on the tumor leads to an ammoniumization of the system which in turn leads to disappearance of the sarcoma. In repeating the experiments with very virulent Jensen's sarcoma, which in the control animals produces a mortality of 100 per cent, a reduction of the tumor to half the size is observed in most instances but here the rapid disintegration of the tumor is followed by a mortal intoxication of the rats.

The authors express the opinion that the growth of the tumor in these experiments is influenced by the fact that the alkali reserve is lowered which indirectly through an unexplained mechanism leads to a permanent immunity. All animals once cured of their sarcoma by the injection of ammonium chloride remained later refractory to subsequent grafts with sarcoma.—*T. Leucutia*.

PICARD, EUGENE, and LIEGEOIS. Epitheliomas pileaires. (Pileous epitheliomas.) *Cancer, Brux.*, 1931, 8, 121-131.

Three cases of cutaneous cancers are described which because of their peculiar structures are considered as pileous epitheliomas. The clinical, as well as the anatomico-physiologic appearance, is discussed. Inasmuch as the microscopic sections contained islands of concentrically arranged basal cells with filamentous cells in the center, a picture usually observed in hair follicles, it was thought that the epitheliomas were of a pileous origin. In two of the cases pigment was included within the areas, which, however, must not be confused with pigment formations observed in nevo-carcinomas which are of a more serious prognosis. The treatment of choice is electrocoagulation with application of radium.—*T. Leucutia*.

REES, W. J., and CLARK, L. H. On the quality and significance of the scattered radiation produced in water subjected to beams of x-rays and gamma rays. *Brit. J. Radiol.*, May, 1932, 5, 432-444.

This article deals with the experiments made for the study of the quality of radiation scattered by water in a vessel exposed to medium and penetrating roentgen rays and the gamma radiation from powerful radium sources. The procedure is described in detail. A copper ionization chamber was used which was found to be quite suitable for roentgen rays but no longer suited for the radium. As a whole, the conclusion is reached that no matter how penetrating the primary beam, multiple scattering will occur in the irradiated volume, resulting in the formation of much softer radiation which forms no inconsiderable portion of the total radiation traversing the medium.—*T. Leucutia*.

LAVEDAN, JACQUES. Recherches sur les modifications du sang chez les malades traitées par les radiations pour cancer du col de l'utérus. (Researches on the modifications of the blood in patients treated by irradiations for cancer of the uterine cervix.) *Radiophys. et radiothérapie*, Volume 2, No. 4, 457-539.

The author carried out a series of investigations on the blood changes which are observed following radiation therapy for cancer of the cervix. In this article, after a detailed review of the literature on the subject, he presents the results of these investigations by citing each case individually. In 14 cases he used roentgen therapy alone, while in another 22 he employed curie therapy. Only non-cachectic patients were chosen, the presence of the carcinoma being verified histologically in every instance. The roentgen therapy consisted in the use of penetrating rays, whereas the curie therapy was carried out in a transcutaneous way with the technique employed at the Radium Institute of Paris in 1924, 1925 and 1926. From the point of view of blood changes the cases were divided into two groups: (a) those in which the modifications occurred between the beginning and the end or immediately following the end of one series of irradiations, and (b) those in which the modifications occurred between the beginning and the end or several days following the end of the entire series of irradiations constituting a radiotherapeutic treatment. In the first group it was found that an irradiation of sixty minutes' duration produced a leucopenia with lymphopenia which was rapidly followed by a polynuclear leucocytosis. At the same time there was a notable shortening in the time of coagulation. The modifications gradually de-

creased during subsequent irradiations, except for the leucopenia which reached its maximum following the second irradiation. In the second group the changes observed most frequently consisted in a moderate diminution of the hemoglobin and of the red blood cells, appearance of leucopenia with lymphopenia, monocytosis, and polynucleosis, which was, however, mostly relative. In anemic patients an increase of the red corpuscles was found due to arrest of the hemorrhages, whereas in cases with secondary infection a polynuclear leucocytosis was not infrequent. With the exception of this latter, all changes rapidly disappeared (within a maximum of two months) leaving no permanent alterations in spite of the magnitude of the doses used.

It is impossible to draw from this study conclusions concerning the prognostic indications, yet it appears that the appearance and persistence of a leucocytosis during the course of treatment, especially when associated with true polynucleosis, indicates a rather unfavorable condition, whereas the appearance of a marked lymphocytosis following irradiation constitutes a good sign, all patients showing this phenomenon having been cured.

All in all, the statistics of the cases treated in 1924, 1925 and 1926 for cancer of the uterine cervix at the Radium Institute of Paris prove that a high percentage of five-year cures may be obtained without impairment of the integrity of the blood.

A bibliography of 40 articles is appended.—*T. Leucutia.*

BORAK, J. Über die epidermiolytische Bestrahlungsreaktion. (On the epidermiolytic irradiation reaction.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1932, 45, 397-406.

The epidermiolytic reaction produced by irradiation was first described by Regaud and Nogier in 1913 and has been used since then under the term of radioepidermitis as a basis of biologic dosage at the Radium Institute of Paris. Coutard is to be credited for having introduced this biologic measure in roentgen therapy. The term epidermiolysis implies a reaction which leads to a destruction of the epidermis alone (and of the hair tissue) without producing a like injury to any other tissue. It develops within five weeks after the application of the irradiation and then it subsides, leading to complete restitution. Thus the reac-

tion may be considered as a temporary and a completely reversible one. As is known, Coutard obtained an epidermiolysis by giving a very large dose of roentgen rays in a fractionated and protracted way. The total dose in his series amounts to 5,000 r, which is spread over a period of three to five weeks. The onset of the reaction depends (1) on the amount of the fractionated dose; (2) on the amount of the total dose, and (3) on the continuity under which the radiation is given. There are also individual variations and there is a certain difference in the sensitivity of the various regions of the body, the neck appearing the most sensitive of all. This, in the author's estimation, is of importance because Coutard figured the minimum tolerance dose of 5,000 r on the basis of the reaction obtained in this region, whereas the author himself has found that in other regions, as for example in the back, the dose may be increased to 5,500 r or 6,500 r.

All in all, the epidermiolytic dose exceeds the usual skin erythema dose at least ten to twelve times. How such a dose can be administered without danger of ulcer or necrosis is one of the unexplained riddles of roentgen science. According to the author, two factors may serve to furnish some sort of explanation: (1) that the expression of the skin tolerance in skin erythema dose must be erroneous, and (2) that the skin tolerance dose varies when the radiation is given at once or in fractions. But even so the author was able to administer a dose as large as 3,000 r in one sitting the reaction having disappeared with complete *restitutio ad integrum* and with no late ulcer showing up within six months, the longest period a patient was observed. If the dose was given in the fractionated way it could easily be increased to 6,000 r as indicated by Coutard. The author also investigated whether it is necessary to protract the irradiation when fractionating it as done by Coutard. This has a certain practical value inasmuch as the protraction consumes considerable time, necessitating the installation of many roentgen apparatus if one wishes to take care of a large number of cases. He found that an epidermiolysis of like degree can be obtained by the simple fractionating without protraction, that is, administering individual doses of higher intensity. The factors used were 0.5 mm. Zn, 30 to 40 cm. distance, 3 to 4 ma., 180 kv., 20 r per minute intensity (Coutard uses a smaller intensity).

In conclusion, the author compares the above doses as expressed in H in Vienna and in Paris and explains the difference (50 Paris H to 125 Vienna H) and the factors which lead to it.—*T. Leucutia.*

JEANNENEY, G. Circulation locale et cancer. (Local circulation and cancer.) *Cahiers de radiol.*, Jan., 1932, No. 7, 154-161. Supplement to No. 2, Jan. 15, 1932, *Gaz. méd. de France.*

Skin cancer forms a good experimental subject because of its frequency and its accessibility. The author therefore has chosen this group for the study of the relationship between local circulation and cancer and he now wishes to generalize the results obtained, although certain reservations are necessary.

Skin cancer occurs most frequently on the face of aged subjects. The reason for this lies in the fact that the skin of the face develops a senile atrophy which is more marked than in other parts of the body. A study by Mme. Bellocq of the distribution of the blood vessels in senile skin, with the aid of opaque injections (térébenthine-minium) and subsequent roentgenograms, revealed that a veritable insufficiency of the local circulation develops with advanced age. A tabulation of some 300 cancers of the face observed at the Cancer Center of Bordeaux since 1925, with regard to the site, revealed that the frequency was greatest in the areas having the poorest circulation. It was further observed that cancers occur with predilection in scars of all sorts (following burn, ulcer, fistula, lupus, roentgen injury, etc.) and in areas suffering from vascular disturbances, such as syphilis (leucoplakia, endarteritis, phlebosclerosis, etc.). This suggests that there is a close relationship between cancer and local blood supply of the area affected. The author is of the opinion that a prophylactic removal of all scars, a systematic treatment of syphilis, with complete suppression of tobacco and alcohol, might prove an efficacious means of combatting cancer. With the same view, he, in 1926, advanced the hypothesis that sympathectomy might have some value in the treatment of certain cancers by provoking vasodilatation and a better blood supply of the area affected.—*T. Leucutia.*

FORTES, ARY BORGES. Syndrome de compression de la queue de cheval par un sarcome

vertébro-méningé. (Syndrome of the compression of the cauda equina by a meningeal sarcoma.) *Rev. sud-am. de méd. et de chir.* Feb., 1932, 3, 143-155.

The author describes in lengthy detail by using numerous illustrations, a case of sarcoma of the third lumbar vertebra which resulted in compression of the cauda equina. The case may be summarized as follows: A woman aged forty-three presented, during a period of 3½ months, a flaccid paraplegia of the lower extremities associated with amyotrophia, grave sensory disorders (from L₃ to S₆), sphincteric troubles, pilomotor, vasomotor and thermic disorders, modification of the arterial pressure, and a typical cyto-albuminous dissociation of the spinal fluid. The roentgen examination showed destruction, with partial collapse, of the third lumbar vertebra, and some involvement of the adjacent second and fourth vertebrae.

Autopsy revealed that the above syndrome was the result of pressure of the tumor which proved to be a primary sarcoma originating from the dura mater on the cauda equina. A surgical intervention was impossible because of the very marked cachexia of the patient.—*T. Leucutia.*

LACASSAGNE, A. L'organe folié de la langue, cause possible d'un diagnostic erroné de cancer. (The foliaceous organ (organum foliatum) of the tongue as a possible cause of erroneous diagnosis of cancer.) *Radiophys. et radiothérapie*, Volume 2, No. 4, 587-594.

Mayer in 1842 described the foliaceous organ (organum foliatum) which is situated on each border of the tongue just in front of the insertion of the anterior pillar of the soft palate. If this organ is hypertrophied a confusion with cancer may occur. The author describes the causes of possible hypertrophy which may be (a) of congenital or (b) of acquired origin. In this latter group a lymphoid hypertrophy, similar to that observed in other tissues of the nasopharynx, is not infrequently encountered. The organ is important also because it may form the site of a chronic infection or of a beginning neoplasm, although this latter occurs less frequently than one would expect. Several plates are included showing the microscopic appearance and one drawing illustrating the clinical appearance.—*T. Leucutia.*

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PARATHYROIDISM—ITS CLINICAL SYMPTOMATOLOGY*

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IT IS a most interesting experience in medical life to witness the development of a new medical entity from its beginning. This good fortune has come during the last generation to a good many of us who are now past mid-life by the development of a few most important new medical chapters, such as the etiology of infections and their treatment by asepsis and the discovery of your specialty, the roentgen ray. Parathyroidism** in comparison with these two great achievements is only a small chapter, but nevertheless most interesting, since, on account of its limited size, we have been able to study all its minute points from the beginning of its development. In our personal experience we have had the fascinating opportunity of learning the new chapter with its roentgenological signs in association with our roentgenologists. We used to go to them and ask, "What do I see?" but this time both they and the clinicians have had to learn together what

parathyroidism is and how it expresses itself on the roentgenogram. Our program of today shows that now we have quite a few experts in detecting the roentgen signs; but it is not two years since Schouten complained that "Not one of the larger volumes of roentgenology gives any information on parathyroidism." The fourth edition (1931) of a most splendid American work on "Roentgenologic Interpretation" does not mention parathyroids as a factor in bony disorders. Yet a few of the illustrations are probably taken from such cases. Camp and Ochsner, in July, 1931, wrote: "No attempt has been made to regard certain changes as characteristic of parathyroidism and nowhere in the standard English and German textbooks on Roentgenology have we found the osseous changes accompanying parathyroidism presented." Since then a few authors, among them several clinicians, have written special articles on the roentgenology of parathyroidism.

The slow reaction of some to this chapter seems to me to be due to the fact that it is hard to get away from the set idea that osteitis fibrosa cystica is an entity, that bone cysts are another entity and giant cell

** We use the word parathyroidism; it tells just as much as hyperparathyroidism, is not as complicated and does not lead to mistakes. We have proposed this in our publications. Cushing in his recent article on "Basophil Adenomas of the Pituitary Body" also presents the same reasoning in connection with hypo- and hyperpituitarism. The terms are too clumsy and easily lead to mistakes.

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932. The following papers were also given in the Symposium on Malacic Diseases of Bone but for various reasons were not available for publication at this time. They will appear later: "Primary Hyperparathyroidism" by E. R. Witwer, M.D.; "Paget's Disease" by Cornelius G. Dyke, M.D., and Haig H. Kasabach, M.D.; "Decalcification (in other endocrine disturbances); Pituitary Origin (Basophil Adenoma)" by M. C. Sosman, M.D. (this will appear as part of a paper by Dr. Sosman on "The Diagnosis of Pituitary Adenomas from the Roentgenologist's Viewpoint").

sarcoma again an entity, and that the most prominent men still publish entities obviously belonging to parathyroidism under such names as I have just mentioned. The time has come when many of the bony changes can be classified to much greater advantage under their etiological factors. In our special case they should now be classified as parathyroidism and not as cysts and so on. Lièvre, a Frenchman, has succeeded in publishing the first textbook on parathyroidism. Its title is "*L'ostéose parathyroïdienne et les ostéopathies chroniques*," showing by this title that there is a distinct parathyroid entity in skeletal diseases. If roentgenologists will take the lead in diagnosing this entity properly instead of reporting osteitis fibrosa cystica or cyst, giant cell sarcoma, Recklinghausen's or Paget's disease, the clinicians will follow, as they customarily do, and a much better understanding of the entities will result and lead, incidentally, to the proper treatment.

Skeletal changes may be caused also by other endocrine disturbances than the parathyroid. Hunter and others have shown that thyroid dysfunctions may cause certain disturbances in the distribution and deposition of calcium. Certain forms of arthritis are due to thyroidism. The Cushing syndrome of basophil adenoma of the pituitary—in other words, pituitarism—is accompanied at times by skeletal changes, and the great complexity of symptoms called xanthomatosis or disturbance of the lipid metabolism also has skeletal changes as an outstanding symptom (Schüller-Christian, Rowland). In certain splenic disorders in children skeletal changes are likewise prominent (Cooley, and others). Whether in these symptom-complexes a polyglandular syndrome exists including a parathyroid disturbance or whether the parathyroid is secondarily affected if there is any breakdown in the endocrine equilibrium is much discussed but not settled at this time.*

* As to the polyglandular upset occurring in these conditions new studies of the cell types in the pathology of all endocrines show that in certain conditions the basophil cells are more disturbed, in others, the eosinophils. This idea is still perhaps con-

To understand the parathyroid disturbance properly, it is of the utmost importance to have a few basic facts in mind. First, if a parathyroid is irritated by hyperplasia or by an adenoma, its function will be stimulated, more parathormone will get into circulation, and this parathormone leads to decalcification of the skeleton. This again expresses itself by an increase of calcium in the blood serum accompanied by a decrease of the serum phosphorus. A negative calcium and phosphorus metabolism is the result; also an increased secretion of calcium and phosphorus in the urine will result. This premise now has to be accepted as a fact. Numerous experiments have been made showing that by injecting parathormone over a period of weeks or by giving large doses in short periods one can reproduce all the symptoms of parathyroidism. The increased parathormone put into circulation will cause hypercalcemia and this increased quantity of calcium in the blood is taken from the great calcium storehouse, the skeleton. This principle being fixed in our minds will help us to understand all the roentgenologic changes we find in parathyroidism. Besides this experimental proof that parathyroid extract in overdoses really is responsible for the syndrome of parathyroidism we have a second practical proof, that is, the clinical evidence that the serious symptoms of the disease are cured by parathyroidectomy, be it the removal of an adenomatous parathyroid or be it a hyperplastic parathyroid.

Comparative studies of other endocrine glands are most interesting. Thyroid extract, if taken in toxic doses, will produce thyroidism. Its cure by operation is well known. Overdoses of insulin will produce hyperinsulinism, the same disease that we now know is caused by adenomatous and hyperplastic processes of the islands of Langerhans. Thus, the parallel can be

troversial, but since these cell disturbances have been observed in all these glands it opens a more understandable view that perhaps these cell groups are the actual carriers of the pathological processes now called endocrine. However, we could understand why the polyglandular upset happens so frequently.

drawn all through the endocrine system.

As to the etiology of parathyroidism, the hereditary element and thereby constitutional makeup, obviously, are prominent factors in its production. A family with osteitis fibrosa cystica in three members, another family with osteopoikilosis in several members, brought under our observation at Harper Hospital, and many other such observations in the literature are proof of the important rôle heredity plays in this group. In another place in our contribution it is brought out that temporary osteomalacic conditions caused by nutritional defects are usually remedied by proper dietetic measures but at times are the origin of a permanent parathyroidism. Dislike for milk has been observed by Hunter and others in the records of their cases. Milk being a main carrier of calcium in our food, this is of etiological significance. As in thyroid pathology we have an endemic goiter, also we know of endemic osteomalacia. Kashin-Beck's disease, to be discussed later, shows that regional conditions may produce decalcification with parathyroid symptoms. In at least 10 of the cases recorded the onset of parathyroidism followed early surgical menopause.

The subjective symptom of the patient in the beginning of his affection is usually pain and the pain is located in the hips and radiates down the legs. *Back leg ache*, I understand, is a known entity in China where osteomalacic conditions seem to be more frequent. For this reason the patient will usually go to the roentgenologist to be examined for sacroiliac disease and many of our patients started their therapeutic efforts with sacroiliac belts and corsets. Later on, however, the pain will attack other bones, arms, chest and even skull. Patients past middle life frequently notice, besides the pain, a bowing of their limbs. They grow shorter and become kyphotic even if they are not confined to bed. A few exceptional cases noticed first a swelling caused by a giant cell tumor in a metatarsus or metacarpus as an early symptom, but usually such symptoms are only pres-

ent in well-developed, advanced cases. The muscular weakness may be an early symptom and should be an indication to watch for parathyroidism. In at least half a dozen cases in the literature severe vomiting due to the hypercalcemia and perhaps to metastatic calcium deposits in the intestines was the early symptom.

The pathological mobilization of calcium from the skeleton under the influence of exaggerated parathyroid activity expresses itself:

1. Biochemically, by the change in the calcium and phosphorus content of the blood and in the metabolism of these elements.

2. Roentgenologically, by bone changes we shall speak about.

3. By changes in muscle tonus. Hypercalcemia leads to lessening of the muscle tonus and this can be measured by the milliamperes needed to contract the muscle (4 milliamperes normal, 7 in parathyroidism, 1-2 in tetany). By the increase in chronaxie, that is, grossly, the time interval between the stimulus and the contraction of the muscle (0.028 second normal, 0.042 in parathyroidism, 0.018 and less in tetany). As to symptomatology, patients complain of lassitude in their muscles, fatigue, frequent falls without cause. The slow muscle action has also been shown in a moving picture (Rowntree) and may be seen, since it also affects the heart muscle, in the electrocardiogram; the so-called R-T interval being long in the tetanic heart muscle and much shortened in parathyroidism (R-T interval: normal 0.026-0.028, in parathyroidism 0.022 in tetany up to 0.034).

4. Secondary calcium deposits. The hypercalcemia will lead to secondary calcium deposits in certain places where infections or other conditions may cause roughening and make an especially inviting location for such deposits from the blood overloaded with calcium. This secondary calcium deposit along the vertebral ligaments, in the intervertebral discs, in blood vessels, perhaps also ribs and internal organs, is

quite important. With the hypercalcemia it causes the gastrointestinal symptoms, the severe vomiting present in some cases of parathyroidism, the albuminuria and other urinary symptoms and, finally, stone formations which accompany a remarkable number of cases of parathyroidism. Besides these gross calcium deposits visible in the roentgenogram, many microscopical specimens now show widespread calcium deposits in liver, spleen, intestinal mucosa, kidneys, etc., in the course of parathyroidism or in post mortems. By understanding these secondary calcium deposits we will also meet with a little friendlier attention than has been the case so far in certain cases of arthritis which Oppel has claimed as being due to parathyroidism. It has been my experience that if one speaks about this symptom of parathyroidism the discussion always follows that arthritis is not caused by parathyroidism, and has nothing to do with it. No one has ever claimed that arthritis in general is of parathyroid origin, but under certain conditions, that is, if hypercalcemia exists, secondary calcium deposits will lead to ankylosis in an otherwise not ankylosing arthritis, and, therefore, parathyroidectomy will prevent and even cure some of these beginning cases of ankylosing arthritis; but to diagnose them, other parathyroid disturbances such as hypercalcemia or severe muscle hypotonia are necessary. Again, arthritis as a symptom is present at times in parathyroidism, but this statement should not be made general to cover the whole chapter of arthritis. Proper diagnosis of the few arthritic cases belonging to this group will prevent mistakes and discrediting of this chapter.

Coming back now to the roentgenological symptoms of parathyroidism, these will be taken up by one of the later speakers in our symposium. I may remark here only that as in practically every pathological condition not one symptom alone is pathognomonic. To speak to the point, absence of roentgen findings should not always exclude the diagnosis of parathyroidism. I

realize that the cases without any roentgenographic evidence are rare and they may be still rarer if the whole skeleton is always examined by the roentgenologist. Three cases will illustrate the point; but there are several others on record:

1. Pemberton and Geddie published a case of a girl fourteen years old, whose chief symptoms were loss of weight, from 86 to 55 pounds, and most severe vomiting spells lasting over days, polydipsia and polyuria, and a serum calcium of 17.6 mg., a negative calcium balance of 0.21. The removal of a parathyroid adenoma cured this patient and the only roentgen finding was a diffuse rarefaction of the bones without any localization. Incidentally, this brings out the importance of having comparisons with standard bones to measure the milder degrees of decalcification, such as comparison with normal bones of the same age, and so forth.

2. A second case of our own concerned a woman about forty years old, who had as the principal symptom a hypotonia of the muscles so that she could hardly walk. The hypotonic muscles were also very painful. There was an increase in the serum calcium, but the only roentgen finding was a disputable decalcification of the pelvis. However, removal of hyperplastic parathyroids brought good relief of her symptoms.

3. The third case is the striking one, that of Bergstrand. This is a case where a parathyroid tumor was actually visible in the roentgenogram of the neck looking like and interpreted first as an aneurysm of the innominate. The case came to autopsy and showed the large tumor that had caused the shadow. The case also showed the typical changes in chemistry and so on. Still the roentgenologic findings during life were absolutely negative. At autopsy, however, the skull cap gave the first intimation that there was some osteitis fibrosa cystica present. The femora and vertebrae looked normal even on roentgenograms taken after autopsy. When these bones that grossly and roentgenologically showed no

changes were examined microscopically an extensive osteitis fibrosa cystica was found. This is quite important. Several pathologists and clinicians specializing in these investigations have proved that in monostotic cysts microscopically the process is far more extensive in the skeleton so that the designation monostotic is not justified. The monostotic Paget changes in the same way will pathologically not stand this name, as they also are, at least microscopically and often roentgenologically, multiple.

Therefore, if there are no skeletal findings or only the very slightest findings of parathyroidism in the roentgenograms, this should not necessarily exclude the diagnosis of parathyroidism if other symptoms prove the diagnosis.

In the same way hypercalcemia and hypophosphatemia and the other disturbances in metabolism are symptoms usually present in the well-developed case, but they may be absent temporarily or very slightly pronounced in the more chronic cases, especially in the arthritic group and the group we find in older people and if you want to include Paget's disease in this chronic type of the affection. The laboratory worker in his enthusiasm over the wonderful progress that has been made in understanding this biochemistry from a parathyroid point of view will miss the diagnosis a good many times if he insists on his findings. They are not necessarily present in every case or at least only mildly pronounced. In other words, the absence of a hypercalcemia and the other chemical symptoms should not counteract the diagnosis of parathyroidism if clinical and roentgen findings and hypotonia, for instance, speak in favor of the diagnosis.

The symptoms of hypotonia again are usually present and some French authors (Bourguignon) even believe that they are much more constant than the calcium disturbances, but in certain well-developed cases that have been proved by successful operation to be of parathyroid origin for some reason or other the changes in chronaxie are not present. If we compare

again other pathological and endocrinological conditions, there is not one pathological entity where, even occasionally, a symptom considered most pathognomonic may not be absent. We have a scarlet fever without rash, we have an aleucemic leukemia and we have a thyroidism without an increase in metabolism. If we operated upon only the cases of goiter that have a high metabolic rate we would miss over 25 per cent of goiters that could be benefited and cured by thyroidectomy. I have gone into this part of the symptomatology perhaps a little too extensively but usually the physician and surgeon look to the roentgenologist to decide the question of parathyroidism.

These various symptoms and osseous changes of parathyroidism will be taken up by other speakers in the symposium.

In the differential diagnosis we have to consider chiefly the exclusion of malignant conditions, metastatic carcinoma of the breast, prostate, and so on. Experienced roentgenologists will have little trouble in excluding most of these conditions. More difficult it seems to be to exclude myeloma. In this condition, as in all other doubtful osseous symptoms, a biopsy is frequently urgently indicated. In a few cases of myeloma we were able to get satisfactory biopsy material from rib foci especially, and in 2 other cases a superficially located myelomatous lesion of the skull gave suitable material for biopsy.

A further diagnostic difficulty is the exclusion of the temporary parathyroid disturbances as they occur in late rickets and osteomalacia, puerperal as well as the type caused by famine or absence of certain vitamins in the food. For this type, if any doubt exists, the therapeutic test is most valuable. Such patients will improve immediately under proper diet, the administration of vitamins, ultraviolet rays, and so forth. Even with all these means the real case of parathyroidism will not improve. A parallel to this exists in the better known picture of thyroidism. The goiter of puberty and pregnancy is just an expres-

sion of the functional adaptation of the thyroid gland to the increased demand for its product in such periods of development. At the same time in rickets and osteomalacia the parathyroid glands' increase in size is an adaptation to the increased demand for its hormone during these disturbances of calcium metabolism; but, as in goiter, these physiologic goiters are apt to become permanent, also rickets and osteomalacia, especially the one after pregnancy, are sometimes just the beginning of a real parathyroidism.

THE TREATMENT OF PARATHYROIDISM

The literature shows that medical treatment with calcium, parathyroid extract, and light, has been of no avail in the rightly diagnosed case. The names of Snapper, Hunter and many other medical men, not surgeons, who have issued this dictum after trying medical care in a good many cases should be sufficient. Moreover, the administration of parathyroid extract and calcium in this condition makes the patient worse just as thyroid extract will usually aggravate the symptoms of a toxic goiter. To be sure, a trial will not do any harm just to exclude the possibility of a temporary parathyroid disturbance, but it should not be continued until severe deformities of the bones and nephritic disturbances render the outlook serious.

The roentgen treatment of parathyroidism will be discussed in a later paper on this program. The treatment in some hands has not been successful, but its trial is rational as an effort to shrink the hyperplastic or adenomatous glands. If this should fail, removal of the adenomatous glands is indicated, is life saving at times and at other times will bring an invalid patient back to normal and prevent great deformities.

A good deal has been written as to whether only tumors of the parathyroid should be removed and not "normal" parathyroids. Even under the microscope it is very difficult to decide what is pathological and what is normal. To be sure, if we

find an adenoma of the parathyroids of some size, say 1 cm. (they have been found up to 6 and 7 cm. in exceptional cases), the issue is a clear one, but the apparently normal parathyroid may show cell changes only distinguishable by the skilled pathologist. It took a long time to understand the intimate pathology of the exophthalmic goiter and no one can doubt any longer that there are cell changes in such goiters responsible for the affection. The results of operations and the removal of only more or less hyperplastic parathyroids without gross changes are the final proof in this question. In removing the parathyroids naturally postoperative tetany has to be guarded against. One should always be sure that one or two functioning parathyroids are left, better two. If in doubt it is best to remove only one or two parathyroids, whether adenomatous or hyperplastic, and if the symptoms require the removal of more parathyroid tissue it should be done at a second sitting. Postoperative treatment of the patient with parathormone as with Lugol's solution after thyroidectomy will take the patient over the postoperative danger period and prevent tetany during the time needed for accommodation to this removal.

The result after operation is most striking, especially the immediate cessation of the unbearable pain that had required morphine and other anodynes for a long time. Patients who have been brought in in an ambulance and could not be turned in bed without causing extreme pain feel free of pain and can be moved comfortably on the first and second postoperative day. Such immediate changes after operation are also observed in other endocrine conditions. Recalcification of the bones after operation has been observed to begin in six weeks, but usually takes longer and sometimes has not been present even a year and more after the operation; still the bone pain has ceased and the function returned. Bone cysts will solidify very rapidly and giant cell tumors will be replaced by good osseous tissue.

In conclusion, a few remarks, are perhaps of importance to the roentgenologist, which are founded on an extensive survey of practically all the literature on the subject of parathyroidism and a personal experience of 50 operated cases and many more clinical and pathological observations:

1. The findings of a monostotic cystic process, a giant cell sarcoma or enchondroma should be an indication to survey by roentgen examination more or less the whole skeleton, spine, pelvis and skull especially, and will often show general changes where only a localized process is outstanding, but general osseous changes would give an entirely different clinical aspect.

2. Also monostotic Paget's disease will show more or less generalized osseous

changes if examined very thoroughly.

3. Vertebral compression, acquired without appreciable injury, without metastatic malignancy should lead to a survey of the whole skeleton and investigation for other parathyroid symptoms.

4. Slipping epiphysis, coxa vara, and pathological fractures not caused by malignancy, should also remind us of the possibility of parathyroidism.

5. A few cases of parathyroidism simulate neurological and vasomotor disturbances, the softened bones causing pressure on the nerves and perhaps the cord. The hypotonia of the muscles causes the cyanotic appearance of the legs. A combination of neurologic and vasomotor symptoms with findings of osteoporotic processes should invite examination for parathyroidism.

REFERENCES

1. BALLIN, M. Technique of parathyroidectomy. *Surg., Gynec. & Obst.*, 1932, 54, 806-808.
2. BALLIN, M. Parathyroidism. *Ann. Surg.*, 1932, 96, 649-665.
3. BALLIN, M., and MORSE, P. F. Parathyroidism. *Am. J. Surg.*, 1931, 12, 403-416.
4. BALLIN, M., and MORSE, P. F. Parathyroidism and parathyroidectomy. *Ann. Surg.*, 1931, 94, 592-609.
5. BERGSTRAND, H. Ostitis fibrosa generalisata Recklinghausen mit pluriglandulärer Affektion der innersekretorischen Drüsen und röntgenologisch nachweisbarem Parathyreoidea-tumor. *Acta med. Scandinav.*, 1931, 76, 128-152.
6. BOURGUIGNON, G., and SAINTON, P. Chronaxie in hyperparathyroidism; study of a case of ostitis fibrosa de Recklinghausen with Paget deformities. *Compt. rend. Soc. de biol.*, 1931, 107, 5-8.
7. CAMP, J. D., and OCHSNER, H. C. Osseous changes in hyperparathyroidism associated with parathyroid tumor; roentgenologic study. *Radiology*, 1931, 17, 63-69.
8. COOLEY, T. B. Likenesses and contrasts in hemolytic anemias of childhood. *Am. J. Dis. Child.*, 1928, 36, 1257-1262.
9. CUSHING, H. Basophil adenomas of pituitary body and their clinical manifestations (pituitary basophilism). *Bull. Johns Hopkins Hosp.*, 1932, 50, 137-195.
10. DRESSER, R., and HAMPTON, A. O. Ostitis fibrosa cystica generalisata with hyperparathyroidism as etiology. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1931, 25, 739-748.
11. HOLMES, G. W., and RUGGLES, H. E. Roentgenologic Interpretation. Fourth edition. Lea and Febiger, Philadelphia, 1931.
12. HUNTER, D. Goulstonian lectures entitled significance to clinical medicine of studies in calcium and phosphorus metabolism. *Lancet*, 1930, 1, 897; 947; 999.
13. LIÈVRE, J. A. L'ostéose parathyroïdienne et les ostéopathies chroniques. Masson et Cie., Paris, 1932.
14. OPPEL, V. A. Parathyroidectomy for ankylosing polyarthritis. *Ann. Surg.*, 1929, 90, 978-981.
15. PEMBERTON, J. de J., and GEDDIE, K. B. Hyperparathyroidism. *Ann. Surg.*, 1930, 92, 202-211.
16. ROWLAND, R. S. Xanthomatosis and reticulo-endothelial system. *Arch. Int. Med.*, 1928, 42, 611-674.
17. ROWNTREE, L. G. *Staff Meetings Mayo Clinic*, Nov. 18, 1929, 681.
18. SCHOUTEN, D. E. Extirpation of parathyroid gland in ostitis fibrosa. *Nederl. tijdschr. v. geneesk.*, 1931, 75, 252-255.
19. SNAPPER, I. Parathyroid tumor and changes of bones. *Arch. Int. Med.*, 1930, 46, 506-523.

PARATHYROIDISM—ITS PATHOLOGIC AND ETIOLOGIC CLASSIFICATION*

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THIS symposium has been arranged in order that a complete survey of the question of malacic diseases of bone may be made, and to give all those interested in the subject an opportunity to discuss the various diseases of this group from their different points of view.

Fragility of bone leading to pathological fracture or to other disturbing symptoms may be due to a great number of causes, and a large number of diseases come under consideration when we discuss this subject. Not all of the conditions discussed this morning will belong properly to malacic disease of bone as such, but they have been included in this discussion for the reason that their roentgen appearances are such that the question of differential diagnosis by the roentgenologist often arises. The following list of diseases will be considered, and each will be taken up by a roentgenologist who has had special experience with that particular disease or special interest in its study:

- Osteogenesis imperfecta
- Fragilitas ossium
- Rickets
- Osteomalacia
- Bone fragility in other endocrine disturbances
- Renal rickets
- Osteitis fibrosa
- Osteitis deformans (Paget's disease)
- Leontiasis ossium
- Giant cell tumors
- Ankylosing polyarthritis (Oppel)
- Multiple myeloma.

Before entering upon the detailed discussion of each disease, a few remarks may be in order as to the classification of this group and the etiological relationships which divide them, both for purposes of

diagnosis and treatment. For our purpose, I think they may best be grouped according to the primary defect of metabolism which, in the light of our present knowledge, we believe is responsible for each group in turn.

In our first group, we place those diseases in which the primary defect is in the mesoblast. In these diseases the mesoblastic tissue as a whole all over the body is probably defective, and as a result of that, the ability of the osteoblastic forming cells to lay down the connective tissue groundwork for bone is lacking. The bones are fragile, not because there is any primary defect in the calcium metabolism, but because the connective tissues are unable to build up a sufficient groundwork upon which enough lime may be deposited. In this class comes osteogenesis imperfecta and fragilitas ossium, probably the same disease, except that in the first case we are dealing with the fetal or infantile manifestation of the affection and in the latter case with the expression of the same pathological process in the adult. These diseases have a particular tendency to be hereditary and familial; to be characterized by multiple fractures which heal normally; to give evidence of their presence by the characteristic blue sclerotics of those affected in this way, and also to show various evidences of multiglandular endocrine disturbances of more or less indefinite form. The important fact is that, as far as we know now, the disease is a primary, congenital, hereditary defect of the mesoblast, and is not amenable to any of the ordinary medical or surgical measures which have been found to affect some of the other malacic diseases of bone favorably. It will be noted that in

* Read in a Symposium on Malacic Diseases of Bone, Thirty third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

both of these diseases the blood calcium and phosphorus levels are usually normal. Fractures, when produced, seem to heal just as promptly as they do in normal bone, but the bones themselves are especially fragile simply because the groundwork for the laying down of lime is insufficient.

In the second group, we place those diseases which are due to a primary defect of lime absorption and fixation. This, in turn, is due either to a deficient intake of calcium in the food, or to an intake insufficient to meet the need of unusual physiological demand, or to a deficient vitamin D intake, or to all of these factors combined. In this group we place rickets and osteomalacia proper; again, probably the same disease, rickets being the infantile type of the disease as it expresses itself in the growing bone, and osteomalacia as it expresses itself in the bone of the adult. Our division of osteomalacia into puerperal, senile, endemic, hunger, and other types is, of course, purely artificial and based upon the particular environmental factor which has called the disease out. Here we have no mesoblastic defect. There is no deficiency of connective tissue, and no lack of capacity on the part of the bone-forming cells to lay down sufficient groundwork for lime to be deposited upon, but the dyscrasia is one having to do with the inability to fix lime in the new-forming bone or inability to obtain enough lime for this purpose. In these cases again we usually find no disturbance in the blood calcium levels. The phosphorus levels are also usually normal, except in those atypical forms of rickets known as high-phosphorus rickets which probably have other relationships. It would be more proper to say that the blood calcium levels are not raised than to say that they are normal, because often in both these diseases low levels are found even to the point of producing marked tetanic symptoms, so that we have rickets with tetany and osteomalacia with tetany rather commonly. It is evident then from this analysis, that the proper treatment of these two diseases is

medical in that if a proper calcium intake is assured, if proper measures are taken in the gastrointestinal tract to insure the absorption of lime by maintaining a proper acidity of the intestinal content, and if enough vitamin D is furnished the body economy to allow proper lime fixation to go on, normal conditions will be restored and we can usually expect a cure of both of these conditions by medical means alone. On the other hand, we must remember that in both rickets and osteomalacia, secondary hyperplasia of the parathyroid gland is the rule, and that in both these diseases we may be confronted in later life with a condition quite similar to the situation that we find sometimes following the adolescent forms of goiter, in that the hyperplasia may be persistent in later life and operative care of the parathyroid may become necessary on account of persistent hyperfunction of the parathyroid called out originally by the functional demands of the original rickets or osteomalacia. It should be emphasized, however, that ordinarily rickets and osteomalacia are not primarily parathyroid in origin and not ordinarily amenable to surgical treatment.

The third group is a rather unsatisfactory one, in that we have used it as a dumping ground for all those conditions which do not seem to fit in elsewhere. In general, it is a characteristic of all these to show an increased lime excretion in the urine, in other words, a sort of leakage of lime due possibly to various causes, but associated with various diseases of other endocrines. The first of these has to do with the pathological fractures that sometimes occur as a result of diffuse bone malacia in severe cases of exophthalmic goiter. Again we find in pancreatic diabetes with marked sclerosis of the pancreas, sometimes diffuse bone malacia possibly related to a chronic acidosis. Cases of basophil adenoma of the pituitary also are commonly affected by bone decalcification sometimes strikingly like those in so-called parathyroid cases, and it has also been reported that certain cases of adrenal tumor have shown un-

usual decalcification of bone. This group is merely mentioned in order to show that in any specific incident of bone malacia a careful study of all the endocrine system should be made before any conclusions are arrived at relative to a specific etiology.

The next group contains one very interesting disease, namely, renal rickets. The bone malacia in renal rickets is one of the most striking which the pathologist sees. In the severe cases practically all the bones of the body may be cut freely with a knife with no evidence of lime salts remaining in the skeleton. The primary lesion in these cases is a nephritis of the contracted kidney type associated with a general arteriolar degeneration and hypertensive phenomena. The primary defect is probably phosphorus retention. The result of this phosphorus retention is the same as we find in young animals in which a high level of blood phosphorus is maintained experimentally, namely, a very marked responsive hyperplasia of the parathyroid gland. The responsive hyperplasia from the parathyroid gland is undoubtedly brought about in an effort to lower the blood phosphorus level, and its secondary result in this case is to increase the blood calcium and to draw upon the lime reserve in the skeleton and diffusely decalcify the bones. The important practical lesson to be learned, of course, is that this disease is primarily a nephritis of very severe grade, and by the time the roentgenologist or the clinician who recognizes it as renal rickets sees it, the condition has gone on far beyond any therapeutic help, and removal of the parathyroid gland or any other therapeutic measure with the idea of alleviating the affection is not to be thought of.

In the next group, we put a collection of diseases which are not primarily in the group under discussion, that is to say, they should not be thought of as malacic bone diseases, but inasmuch as the bone defects produced by them are so often seen by the roentgenologist and must so often be differentiated from the others, we thought it well to discuss them in this place. In this group

are those bone defects that are produced by erosion as a result of pressure from other tissue, either outside or within the marrow of the bone, pressing upon the bone and eroding it very much as an aneurysm or other new growth eats away or dissolves bone in its vicinity. Because of the widespread manifestations of abnormal tissue in these diseases, we find bone defects of the skeleton which are distributed throughout the bones of the body and involve the skull and pelvic bones as well as the vertebrae, ribs and long bones many times in all of these diseases. In this group we mention Schüller-Christian's disease, Gaucher's disease, Niemann-Pick's disease and Hodgkin's disease. We all immediately, of course, recognize that these diseases are not primarily related to the bones themselves, but that the bones suffer as a result of pressure and erosion from the abnormal tissue which characterizes each of these conditions in turn. The differential diagnosis, of course, is not always easy, and the roentgenologist often finds it quite difficult to separate members of this group from various others which belong to the truly malacic classification. We might also in the same category place generalized carcinomatosis as it sometimes manifests itself in cancers of the breast, thyroid, prostate, adrenal and sometimes in other organs. Many persons would be inclined also to place in this group multiple myeloma of the bone, but as I shall mention later it is my personal belief that multiple myeloma of the bones will ultimately be found to belong to the osteitis fibrosa cystica group and to be considered merely as a malignant end-stage of that affection.

In our last group, we place all those diseases which at the present time we feel are caused by either a primary parathyroidism or at least by overactivity of the parathyroid gland brought on by some special cause. This group is of special therapeutic importance in that the evidence at present seems to point to the fact that operation and removal of some of the parathyroid glands leads, in most cases, to either com-

plete clinical cure or at least marked clinical benefit. In this group we place osteitis fibrosa, osteitis deformans or Paget's disease, leontiasis ossium, the ankylosing polyarthrititis of Oppel, certainly multiple cases of giant cell tumor and possibly single giant cell tumor, and also provisionally, at least, multiple myeloma of bone of the plasma cell type. I will not enter at this time into any detailed discussion of these various diseases or into any discussion of our reasons for placing them together because I expect that all these points will be brought out during this morning's discussion. The place of osteitis fibrosa cystica generalisata as of parathyroid origin and associated with parathyroid tumor is probably completely established at this time. The position of Paget's disease or osteitis deformans is possibly still controversial, although we have material which we believe points strongly to its acceptance as a member of this group. Hamburger's work probably justifies the placing of

leontiasis ossium as a special clinical type of osteitis fibrosa, and Oppel's work in Leningrad on ankylosing polyarthrititis seems to give strong evidence of overactivity of the parathyroid gland in these special forms of ankylosing rheumatism. This morning's discussion will bring out considerable material both for and against the question of allowing giant cell tumor a place in this classification, but our own material as it accumulates certainly seems to justify the classification at the present time, and briefly I may say that my own study of our cases of multiple myeloma has convinced me that multiple myeloma is not a disease of the bone marrow system, that it does not come from the blood-forming cells nor is it related to them in any way, but that it is a primary osteoblastic tumor arising from the primitive osteoblasts and at present should be considered as a malignant manifestation or a malignant end-stage of osteitis fibrosa cystica. There should be considerable discussion on this point as well.



RICKETS*

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THE subject of rickets, as it has been assigned me in this symposium, has been divided into the fetal, the infantile, and the late types. In an earlier communication before this Society, I presented the subject of infantile rickets from the standpoint of the roentgenographic changes as manifested in the long bones. To this, I can add nothing. In the brief time allotted me, it is impossible to give more than a cursory review of these three types, emphasizing their roentgen signs and characteristics and their relationship to the other malacic diseases touched upon in this symposium. For much of the material, references, etc., in this paper, I am indebted to the very comprehensive monograph of Hess.

FETAL RICKETS

Before attempting any description of fetal rickets the question must first be answered, if possible, does fetal rickets actually occur? Is there a congenital factor which makes fetal rickets possible? Schmorl, in a very detailed study of over 100 full-term and prematurely born infants, failed to find histological evidence of rachitic lesions in a single instance. Previous to this, Pommer had had the same result from his study. Kassowitz, however, believed that most cases of rickets were congenital in origin, basing his opinion on the pathological changes found in the long bones, but Hess considers that his histological criteria have been proved to be unsound.

Ylppö was one of the earlier workers who attempted to prove the existence of fetal rickets by roentgenological studies. In 88 premature infants he found roentgenographic evidence of rickets in the long bones in 5 children. He believed that these

lesions had developed during intrauterine life and concluded that rickets is of fetal rather than of postfetal origin. Hess and Weinstock studied the epiphyses of 250 new-born infants and could find no roentgenographic evidence of any rachitic lesion. They did find a peculiar and unexplained tendency to cupping of the diaphyseal ends such as might be termed incipient rickets in later months, but they did not regard this as conclusive evidence of rickets. Foote believes that the beaded ribs sometimes seen in premature infants at time of birth are not due to rickets of fetal origin but rather to lack of ossification due to prematurity. According to Hess, chemical analyses of the blood of the new-born do not point to the existence of congenital rickets.

Farrell and Burt have recently reported a study of a series of 48 new-born Negro infants, in whom cupping of the long bones was found in 7; of these, unmistakable evidence of clinical rickets appeared in 4, from five to thirteen weeks after birth. A similar deformity was found roentgenographically in still-born infants, but on histologic examination no microscopical evidence of rickets could be found. When studied histologically, the cupping was believed to be due to a concave variation from the usual normal straight or convex line at the junction of the zone of proliferating cartilage and the zone of preparatory calcification. They conclude that recognizable cupping in the roentgenogram is sometimes normally present in the ends of the long bones of new-born infants, caused by a normal variation in the manner in which the zone of preparatory calcification joins the zone of proliferating cartilage.

Previous to the publication of the paper

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of Farrell and Burt, Maxwell and Miles, in reporting on osteomalacia in China, mentioned the fact that 2 out of 3 fetuses from mothers with active osteomalacia showed curious changes about the ends of some of the long bones, especially the ulna. This at once suggested to them the possibility that this might be rachitic in origin. In 1930, Maxwell and Turnbull reported 2 cases of fetal rickets in children born from mothers who had been suffering from prolonged and untreated osteomalacia. In one of the cases, evidence of fetal rickets was only afforded by the roentgen ray, and in the other, the badly preserved condition of the bones, Maxwell says, detracted, to some extent, from the value of the evidence presented. But in 1932, he was able to confirm this evidence by an indisputable case which was carefully studied by himself from the clinical side and by Turnbull from the pathological side.

Turnbull states that the last case (1932) establishes beyond doubt the occurrence of rickets or of osteomalacia in the fetus. The fetuses from osteomalacic mothers may show a disturbance of calcification which may be osteomalacic but which cannot be differentiated histologically from that in rickets of young children. This disturbance of calcification is complicated by, and its histological evidence is to a greater or less extent obscured by, an atrophy due to diminished osteoblastic activity. Both conditions are evidently due to the food of the mothers, which was grossly deficient both qualitatively and quantitatively, being comparable to that which at the end of the great war gave rise to hunger osteomalacia in Central Europe.

This work of Maxwell and Turnbull seems to establish fetal rickets definitely as an undoubted disease. It is interesting to note that the illustrations of the roentgenograms which accompany the papers of these authors show not only cupping of the diaphyseal extremities but a distinct frayed-out appearance of the zone of preparatory calcification. This change was apparently

absent in the cases studied by Hess and Weinstock, and Farrell and Burt, as they make no mention of it.

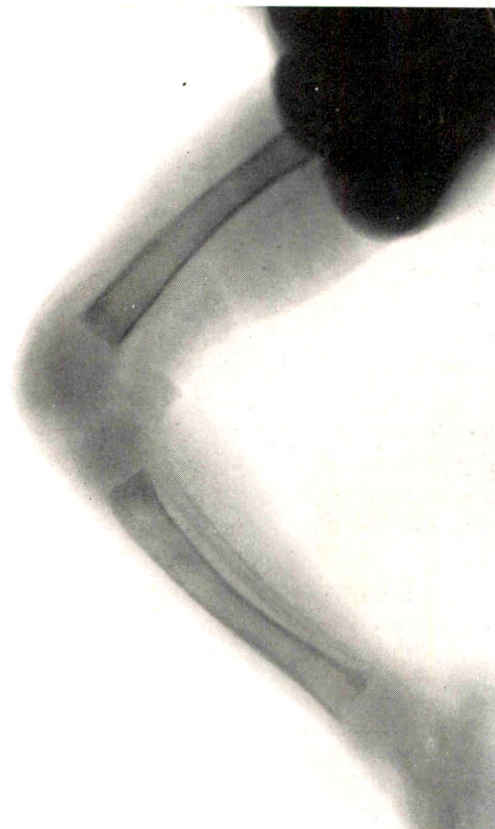


FIG. 1. Passive rickets, first stage. Generalized decalcification of the bones, swelling of the resting cartilages of the epiphyses, fraying and thinning out of the diaphyseal extremities. Slight periosteal reaction.

INFANTILE RICKETS

As in most of the diseases of infancy and childhood in which the skeleton is affected, rachitic changes are manifested to the greatest degree in the areas in which bone growth occurs. Growth in length proceeds from the epiphyses at the ends of the long bones, i.e., the endochondral areas of bone growth and the increase in width occurs in the endosteal and periosteal areas.

Infantile rickets has been divided into two types by Wimberger, the passive and the active. The former is found in severe cases, the child lying on his back and not moving his extremities due to

muscular weakness. The active type is found in children who show, in spite of the rickets, a good state of nutrition and bodily activity. The essential point of differentiation in the roentgenogram is the cupping



FIG. 2. Passive rickets changing to active, in the second stage. Healing has begun as shown by the formation of the new zone of temporary calcification and of a layer of osteoid bone at the ends of the diaphyses. Early cupping of the diaphyseal extremities can also be seen.

or spreading out of the diaphyseal ends which is found in the active type. This is an accompaniment, apparently, of muscular activity.

Roentgenographically, it is possible to divide both types into three stages covering the progress of the disease from the first roentgen signs to complete healing. The first stage includes the period from the onset of beginning skeletal changes to the first sign of healing as shown in the roentgenogram. The second stage includes the healing interval from the reappearance of the zone of temporary or preparatory calcification to the dense bone stage which is the stage of complete healing. The third stage might be called the stage of residual deformity in those cases which, in previous

stages, have developed the characteristic deformities of rickets. Serial roentgenograms are necessary for the detection of the changes.

While cupping seems to be the result of muscular activity, transforming the passive into the active type, there seems to be a variety of the passive type which is of mild degree, often manifesting itself in patients who have had excellent care and supervision of their diet and proper exposure to sunlight and ultraviolet rays. Clinical signs of rickets are usually detected, such as a Harrison's groove combined with a mild rosary, and very often an increased lateral mobility of the knee joints or a true genu valgum. As a rule, on roentgen examination, no evidence of rickets can be found other than an increased density of bone with a broad, wide, dense zone of temporary calcification. No actual bowing or other deformity than the genu valgum above noted occurs in this type of case.

In the metaphysis, or the region of the end of the diaphysis, is shown the first recognizable roentgen sign, a tendency to loss of calcium and a fraying out of the normal, sharply outlined, zone of temporary calcification. This assumes a thin, broken appearance as the disease progresses. Ultimately, it may entirely disappear. The cortex becomes streaked and in the cancellous bone of the metaphysis, coarse trabecular shadows can be noted running through it in irregular fashion. In the passive type no cupping of the diaphyseal ends can be seen, but if the child is active, this sign soon appears and is found in varying degree. The calcium deposition surrounds the swollen epiphyseal cartilage, and appears as a thin line, spreading in a semicircular fashion about the resting cartilage of the epiphysis. In severe cases, fractures of the shafts may occur.

In the second stage or period of healing and repair, the zone of temporary calcification, as it reappears, is at first faint, but later becomes wider and denser. Between this and the site where the old zone of

temporary calcification was located at the beginning of the disease is a layer of homogeneous appearing bone, containing less calcium, of varying width, which is caused by the layer of osteoid bone. As repair proceeds, this gradually assumes a denser appearance. The reappearance of the zone of temporary calcification is overlooked unless serial roentgenograms are made at intervals of at least one week. If a relapse occurs (Schmorl), the new zone of temporary calcification will be broken through, and the line of temporary calcification corresponding to the period of healing will be partially or completely buried in the widened distal portion of the diaphysis. Occasionally, in the roentgenogram, several of these buried lines may be seen, indicating as many attempts at healing with relapse. In the active form the new zone of temporary calcification appears as in the passive form and the osteoid zone is also similar. The latter gradually becomes more calcified and denser until healing is complete. Since bowing of the shaft is the usual finding in the active form, thickening of the cortex on the concavity of the curve appears as a diagnostic sign. In some cases of the active form, healing is shown as a filling-up process of the cupped end from the bottom to the top of the cup by calcium deposition (Göttche). In this type of case, the formation of a new zone of temporary calcification often cannot be detected.

The dense eburnated cortex of the long bones is the characteristic appearance of the third or completely healed stage. Along with this are the thick, broad and dense zone of temporary calcification and the transverse striations or thin fine lines which run transversely through the metaphysis. The thickened cortex on the concavity of the bowed bones is dense and eburnated.

While the above changes in the metaphysis have been occurring, the disease has been progressing simultaneously in the epiphysis. In the first stage an increased width and opacity of the resting cartilage can be detected in roentgenograms show-

ing excellent soft part detail. The centers themselves have faint or moth-eaten outlines, provided they have already appeared in the roentgenogram. The distinct limit-

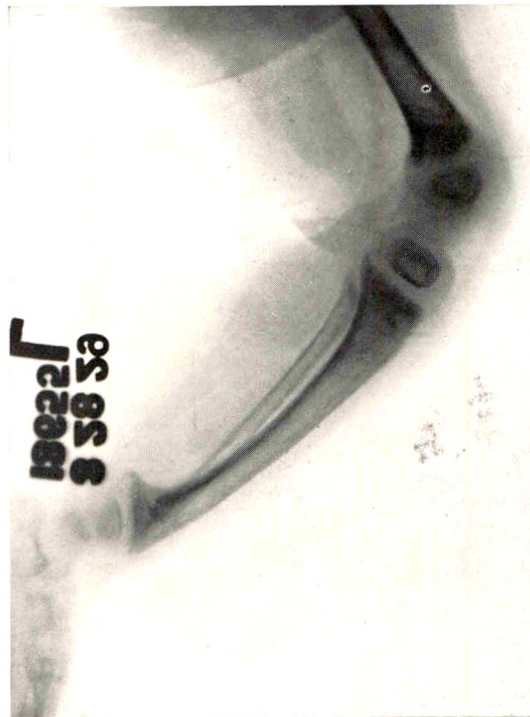


FIG. 3. Active rickets, second stage. Cupping is prominent, new zones of temporary calcification have formed and osteoid zones are fairly well calcified.

ing border of the center may be entirely absent, and its cortex may appear only as a faint haze. In mild infantile rickets, the epiphyseal centers appear in the roentgenogram without visible delay, but in moderately severe or very severe rickets no new centers appear (Plaut). They are, however, actually laid down as can be demonstrated histologically, but owing to deficient calcification, they remain invisible until healing sets in. If roentgen examinations are made after repair when calcium deposition has begun, epiphyseal centers are shown of such size as to indicate their previous existence for several months. If the rachitic process is acute, ossification centers that have been visible may become invisible owing to loss of calcium. Only in

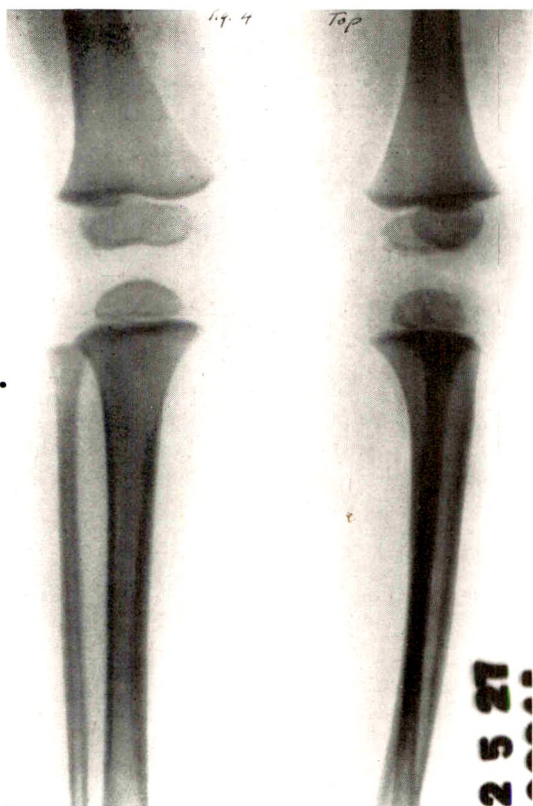


FIG. 4. Passive rickets, final stage. The only roentgen signs are the increased density and width of the zones of temporary calcification. This patient had laxity of the capsules of the knee joints, evidence of an old mild rachitic rosary and a mild degree of pronation of the feet.

acute cases accompanied by severe disturbance of bodily development is there actual delay in the development of the centers.

In the second stage, after healing has begun, the time of reappearance of the epiphyseal centers depends upon the severity of the rachitic process. Sometimes a new zone of temporary calcification can be seen, encircling an osteoid layer of bone, just as at the diaphyseal ends. The moth-eaten centers become homogeneous and ultimately the bone regains its normal structure. It seems that the osteoid zone in the epiphyseal center usually calcifies at the same rate as the analogous layer in the end of the diaphysis. In the active form the centers broaden to meet the widened diaphyseal ends. Some show large areas

which are slow in filling in with calcium. In the final stage of complete healing the centers are dense and almost eburnated similar to the appearance of the cortex of the shafts.

Periosteal changes occur in rickets manifested by a periosteal thickening along the borders of the shafts. This is difficult to distinguish from the periosteal proliferation seen in congenital syphilis. As the process advances the periosteum loses the thinly streaked or striated appearance and as osteoid bone beneath the periosteum becomes calcified the striations, horizontal with the shaft, are merged with the dense shadows of the cortex.

In the flat bones there is gradual loss of calcium salts depending upon the severity and the rate of development of the rachitic process. When the disease reaches its height, the bones present a moth-eaten, streaked appearance, resembling that of the cortex of the shafts of the rachitic long bones. Often cystic areas develop around the borders of the flat bones, especially in the scapula and the ilium. During the stage of repair, osteoid zones sometimes form around the flat bones and finally they assume the same dense and eburnated appearance seen in the fully healed shafts of the long bones.

In the skull, craniotabes is shown roentgenologically by marked thinning or total absence in isolated areas of both tables of the skull. Thin, fine lines due to fracture are often seen. As healing proceeds, the tables gradually thicken, especially in the frontal or occipital areas, and the cortex shows a thick, white and eburnated texture, forming the typical rachitic bosses. In these cases the differential diagnosis from the hypertrophic type of osteitis due to congenital syphilis is difficult. Craniotabes is usually seen in the first few months of life manifesting itself at an earlier date than the rachitic changes in the long bones.

LATE RICKETS

It has been said (Tubby) that true rickets is the only disease which proceeds to

eburnation, with arrested growth in length of the long bones, while the width and density of the bones is much increased. Thus rickets reaches its final stage about the age of five years, after which time the disease never returns, although the deformities produced by it remain. Many observers, however, do not agree with this, claiming that recrudescence may occur, that rickets may reappear from time to time and occasionally cases are seen in which obvious rachitic deformity comes on in early adolescence or even in early adult life. The first case of late rickets was apparently reported by Drewitt who in 1880 showed at the Pathological Society (London), a case of active rickets in a boy ten years of age, the diagnosis being subsequently verified post mortem. Schmorl and Pommer by their researches made it clear that rickets and osteomalacia are essentially one and

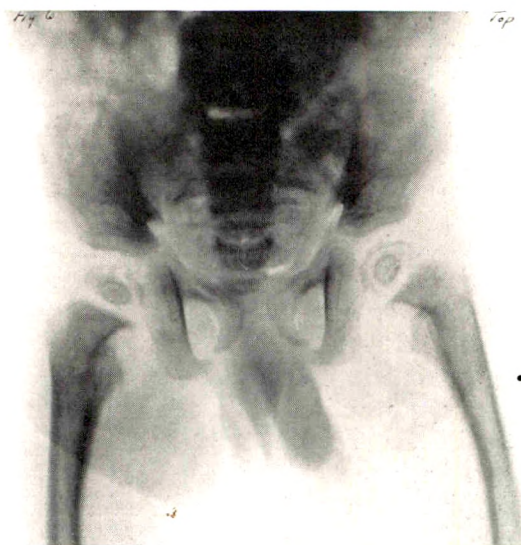


FIG. 6. Prominent new zones of temporary calcification and osteoid zones have formed about the epiphyseal centers of the femoral heads. Second stage, active rickets.



FIG. 5. Active rickets, final stage. Bowing is marked, cortex is dense and almost eburnated, and there is marked thickening of the cortex on the concavity of the rachitic curve. The epiphyseal centers are broadening to meet the widened and previously cupped diaphyseal extremities. The zones of temporary calcification are broad and dense.

the same pathological condition, the main distinction being the age of the individual. Thus late rickets occupies a position between rickets and osteomalacia, the first occurring in infants and the second in adults. It consists of an intermediate group of cases, the lower boundary of which, Hess states, was set at four years by Schmorl, with whose opinion he agrees. At the other extreme, it is more difficult to draw a line of differentiation between rickets and osteomalacia. Usually all cases up to the age of eighteen or twenty years are considered as late rickets. Under such classification would then be placed the cases which have been reported as juvenile osteomalacia. An essential but extremely difficult point in the diagnosis is the exclusion from late rickets of all cases of recrudescence and cases which have been termed rachitis inveterata.

Hess divides the reported cases clinically into two main groups: a general type and a localized type. In the first, there occurs generalized pain on walking or standing. The gait becomes uncertain and waddling. Beading of the ribs may occur, and with this may be associated clinical enlargement

of the epiphyses. There may also be some deformity of the legs, genu varum or valgum, bowing of the humerus and of the forearm, scoliosis and kyphosis, clubbed fingers and, finally, after several years, stunting of the growth.

The roentgenographic appearance is much like that of infantile rickets in many cases which have been reported. Generalized osteoporosis, frayed-out appearance of the diaphyseal ends and the epiphyseal centers, coarse trabecular shadows in the metaphyses and bowing are often found. In mild cases there may be only an increased width of the clear space between the epiphysis and the end of the diaphysis. Attention has been drawn to the less marked clinical enlargement of the epiphyses in late as compared with infantile rickets, but Hess considers that Schmorl has satisfactorily explained this by the fact that the resting and proliferating cartilage of the epiphysis is much narrower at the age when late rickets develops, endochondral ossification having almost ceased at that time of life.

In the local form, isolated deformities of the long bones such as knock-knee or bow-legs have been considered by some to be due to late rickets, especially when accompanied by slight widening of the epiphyses or a slight rosary. In such instances the local deformity is regarded as a manifestation of a general process which is latent in the apparently unaffected portions of the skeleton. It is generally admitted that such cases are due to rickets. Hess thinks that the so-called deformities of adolescence which occur in patients who may have been brought up under the most favorable hygienic conditions are not to be definitely classed as late rickets inasmuch as definite proof of their rachitic origin has not yet been obtained. At present the majority of writers incline to the view that only a small number of these cases are due to rickets.

Dr. Vogt, who speaks later in this symposium, will show cases of renal rickets. The bone changes which he will describe are similar in many ways to those of the late type here described.

RELATION OF THE PARATHYROID GLANDS TO RICKETS

In his discussion of the relation of the parathyroid glands to rickets, Hess states that Erdheim made one of the first reports on the parathyroids in rickets. He studied rickets experimentally in rats and found a marked increase in the size of the parathyroids, this increase being the result of general hyperplasia of the glands and of hypertrophy of the individual cells. He regarded this hypertrophy as the result of rickets rather than as a cause. In a later study of rachitic children, he could not decide from the microscopic appearance of the parathyroids whether they had been removed from a rachitic or a non-rachitic child, but he was impressed by the fact that the glands from rachitic children were relatively large and full on microscopic examination. Ritter carried out a study in rachitic children and came to the conclusion that in prolonged and severe rickets a marked enlargement of the parathyroids comes about which seems to be associated with the period of early healing. Pappenheimer and Minor (also quoted by Hess) thought that there was a very definite increase in size of individual cells.

Hess draws attention to the fact that in none of these studies were analyses of the blood carried out and therefore it cannot be ascertained whether or not the cases of rickets were associated with low calcium and evidences of tetany. Pappenheimer (1930) concluded after experimental study that acterol is antirachitic in the absence of the parathyroids, his experiments having been performed on parathyroidectomized rats. Hess and Lewis had earlier suggested that irradiated ergosterol raised the calcium by stimulating the activity of the parathyroid glands. They found that when irradiated ergosterol was fed in large amounts to animals suffering from the low calcium type of rickets, the serum calcium promptly rose, but after the parathyroids had been extirpated, no benefit accrued. However, Shelling has found that viosterol is efficacious in raising the serum calcium level in rats after the parathyroids have been removed.

Hess summarizes the function of the parathyroids as the medium of stabilization of calcium metabolism. Rickets places a heavy burden on their activity and this may lead to hypertrophy. Thus he suggests that if rickets has lasted a long period of time, they become incapacitated and are no longer able to maintain the normal level of calcium in the body and the blood, and this finally brings about an increased irritability of the nerves.

Erdheim reported a case of parathyroid tumor with associated findings in the bones of late rickets and he pointed out the fact that where changes in the parathyroids have been found at autopsy they have been noted in the cases of the late or delayed type of rickets. Hess concludes that the subject may be summarized by the statement that the association between hypertrophy of the parathyroids and osteomalacia and tetany is definite and unquestion-

able but that its connection with uncomplicated rickets of the low phosphorus type remains to be substantiated, although it is probable that an interrelationship exists.

Thus, while the interrelationship of rickets and the parathyroids is probable, extirpation of the latter is not indicated from clinical and pathological studies as in the case of osteitis fibrosa cystica. Even in a case of late rickets with an associated parathyroid tumor, extirpation of the latter would likely be of doubtful benefit because large doses of viosterol have been efficacious in curing late rickets when small doses in the same cases have failed. Sufficient doses of vitamin D and phosphorus effect cures in high calcium rickets. In infantile rickets, extirpation is certainly not indicated.

I wish to thank Dr. Mitchell I. Rubin and Dr. Irvin Stein for their assistance in the preparation of the section on the relation of the parathyroids to rickets.

REFERENCES

1. ERDHEIM, J. Zur normalen und pathologischen Histologie der Glandula thyroidea, parathyroidea und Hypophysis. *Beitr. z. path. Anat. u. z. allg. Path.*, 1903, 33, 158.
2. FARRELL, J. T., Jr., and BURT, E. F. Nonrachitic cupping of long bones in the new-born. *J. Am. M. Ass.*, 1932, 98, 1801-1803.
3. FOOTE, J. A. Clinical Pediatrics. Diseases of the Bones, Joints, Muscles and Tendons. Vol. VII. D. Appleton & Co., New York, 1927.
4. GÖTTSCHE, O. Zur Röntgendiagnostik der Rachitis. *Jahrb. f. Kinderh.*, 1927, 116, 329-337.
5. HESS, A. F. Rickets Including Osteomalacia and Tetany. Lea and Febiger, Philadelphia, 1929.
6. HESS, A. F., and LEWIS, J. M. Clinical experience with irradiated ergosterol. *J. Am. M. Ass.*, 1928, 91, 783-788.
7. HESS, A. F., and WEINSTOCK, M. Quoted by Hess, ref. 5.
8. KASSOWITZ, M. Quoted by Hess, ref. 5.
9. MAXWELL, J. P., and MILES, L. M. Osteomalacia in China. *J. Obst. & Gynaec. Brit. Emp.*, 1925, 32, 433-473.
10. MAXWELL, J. P., and TURNBULL, H. M. Two cases of foetal rickets. *J. Path. & Bacteriol.*, 1930, 33, 327-338.
11. MAXWELL, J. P., HU, C. H., and TURNBULL, M. H. Foetal rickets. *J. Path. & Bacteriol.*, 1932, 35, 419-440.
12. PAPPENHEIMER, A. M. The antirachitic action of cod liver oil and irradiated ergosterol in parathyroidectomized and thymectomized rats. *J. Exper. Med.*, 1930, 52, 805-812.
13. PAPPENHEIMER, A. M., and MINOR, J. Hyperplasia of the parathyroids in human rickets. *J. Med. Research*, 1920-1921, 42, 391. Quoted by Hess, ref. 5.
14. PLAUT, H. F. Röntgenuntersuchung über die Knochenkernbildung bei Rachitis. *Ztschr. f. Kinderh.*, 1924, 38, 540-556.
15. POMMER, G. Untersuchungen über Osteomalacie und Rachitis. Leipzig, 1885. Quoted by Hess, ref. 5, and Maxwell and Turnbull, ref. 10.
16. SCHMORL, G. Ueber Rachitis tarda. *Deutsches Arch. f. klin. Med.*, 1906, 85, 170. Also: Die pathologische Anatomie der rachitischen Knochenerkrankung, etc. *Ergebn. d. inn. Med. u. Kinderh.*, 1909, 4, 403.
17. SHELLING, D. H. Calcium and phosphorus studies. II. The effect of diet and viosterol on tetany and on the serum calcium of parathyroidectomized rats. *J. Biol. Chem.*, 1932, 96, 215-228.
18. TUBBY, A. H. Deformities Including Diseases of the Bones and Joints. Macmillan and Co., London, 1912.
19. YLPPÖ, A. Das Wachstum der Frühgeborenen von der Geburt bis zum Schulalter. *Ztschr. f. Kinderh.*, 1919, 24, 111. Quoted by Hess, ref. 5.

OSTEOMALACIA*

A BRIEF REVIEW OF THE MODERN CONCEPTION OF THE DISEASE

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TERMINOLOGY

THE term "osteomalacia" is literally applicable to all of the diseases included in this symposium but tradition restricts its use to the particular softening of spine, pelvis and extremities that sometimes occurs in pregnant or lactating women.

The fundamental process is probably identical with the rickets of children where growth plays an important rôle but the special calcium demand of pregnancy or lactation is absent, and with senile or famine osteoporosis where diet deficiency is the sole factor. Much less close is the relationship to the osteoporosis that follows primary parathyroid disease or dysfunction, to Paget's disease or to osteitis fibrosa cystica.

Physiologists are not inclined to be dogmatic in statements dealing with the function of the parathyroids but at least there is agreement in the belief that these tiny structures are intimately concerned in the metabolism of calcium and that certain parathyroid tumors produce decalcification of the pelvic bones practically identical with that seen in the osteomalacia of child-bearing women.^{6,12,20} Furthermore, diets that will probably produce osteomalacia in animals if continued long enough do frequently cause enlargement of the parathyroids.^{36,38,39} Some have interpreted these facts as proof that osteomalacia is a parathyroid disease. The opposing view, which we support, considers that in osteomalacia parathyroid action is merely incidental, diet deficiency the active agent.

We wish to acknowledge that except for the fact that one of us was associated formerly with Maxwell in Peiping and did most of the roentgenographic work con-

nected with his earlier publications,⁴³ our knowledge of the subject is drawn entirely from the references listed, particularly from the splendid review by Park,⁵² the monograph by Hess²³ and the lectures of Trousseau,⁶² the latter having been brought to our attention by Franklin McLean and loaned to us from his private library.

RICKETS

Since osteomalacia is the rickets of adults it will be well to review briefly the development of knowledge of that better known condition.

Glisson in 1650 recognized the disease as a distinct entity. Trousseau in 1849 understood its similarity to osteomalacia and knew how to treat it with cod-liver oil. Pommer in 1885 described the microscopic picture of the disease. Palm⁵¹ in 1890 had a clear understanding of the rôle of sunlight in rickets but his publication made little impression on the medical opinion of his time. Buchholz⁹ in 1905 attempted to treat rachitic children with artificial light but was not successful and his work was not generally known. Hopkins²⁵ and von Hansemann^{21,22} in 1906 appreciated the fact that minute elements in the diet and an abundance of outdoor light were essential to health while their absence produced rickets. This view was advanced again in 1914 by Funk¹⁸ but meanwhile Findlay,^{14,15,16} working in Glasgow in 1909, concluded that the rickets he was able to produce in puppies was due to lack of exercise. Mellanby^{47,48,49} in 1918 convinced himself that rickets is primarily a deficiency disease and though he was mistaken in his opinion as to the exact nature of the deficiency, Park credits him with turning scientific opinion into the channels which

* From the Division of Roentgenology, Department of Medicine, University of Chicago. Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

it has followed ever since. Huldschinsky²⁸ in 1919 published conclusive evidence to show that under certain conditions the radiation produced by a mercury arc quartz lamp will produce calcification and healing in the lesions of rickets.

Cod-liver oil had been used empirically for many years⁶² in the treatment of rickets but Park and his associates, publishing in 1921, were the first to present experimental evidence of its usefulness. Their demonstration of calcification and healing in the cartilages of rachitic rats led to the development of a technique for the biological standardization of the oil, which has been of tremendous importance both in the clinical use of the oil and in a clearer understanding of the disease on which it exerts a truly miraculous effect.

Steenbock and Black⁵⁹ in 1924 published their paper entitled "The induction of growth-promoting and calcifying properties in a ration by exposure to ultra-violet light" and the newer knowledge on irradiated ergosterol that followed is too recent and too generally known to require further consideration here.

PATHOLOGY OF OSTEOMALACIA

In spite of Trousseau's⁶² insistence that rickets and osteomalacia were essentially identical and his proof that both might be cured by the administration of cod-liver oil, the fact was not generally accepted. On the contrary, Virchow was presently teaching that the two diseases were quite different because in the one newly forming bone failed to calcify and, in the other, bone that had once been well calcified lost its calcium probably due to a leaching action of excess acid in the blood. Cohnheim in 1889 revolutionized bone physiology by demonstrating that skeletal tissue like all other tissue is constantly being destroyed and reformed, and McCrudden,⁴⁶ in the light of this concept, restudied the osteomalacia problem in 1908 and enunciated a "new pathology" which is generally accepted at this date, a quarter of a century later.

McCrudden's careful work stands out

as some of the finest of the osteomalacia literature. He proved by philosophical reasoning as well as by laboratory experiments that the hyperacidity theory was untenable and he uncovered some of the chemical errors that had contributed to this faulty concept of the disease. Clinical and experimental data were marshalled to destroy the idea that ovarian action was intimately connected with the malady and that castration offered a cure. Microscopic and chemical studies were interpreted as showing that the physiological destruction of old bone and its replacement by new osteoid tissue went forward in a normal fashion but for some reason the calcium liberated from the old bone was not utilized by the organism to calcify the new osteoid tissue but instead was lost from the body, principally in the feces.

DIAGNOSIS

The late stages of osteomalacia, marked by gross distortion of the female pelvis, are not apt to be missed at physical examination, and since in most cases of this sort the disease is no longer active and recalcification has occurred, roentgenograms are easily made and easily interpreted.

The active stage is extremely rare in the United States and most of Europe and this fact alone undoubtedly tends to make physicians fail to recognize the occasional cases that may come their way. In China,⁴¹ India,⁵⁵ and certain parts of Europe, however, active cases are being uncovered in increasing numbers and where the condition is suspected diagnosis is not difficult. There is pelvic pain ranging from a dull backache to intense pain on the slightest movement. Gait may be disturbed only to the extent that the subject walks with a characteristic waddle or the disturbance may be so severe that the recumbent patient cannot feed herself, much less stand or walk. The calcium and phosphorus content of the blood is usually but not invariably disturbed, the stool almost always contains an excess of calcium, and roentgenograms show an unmistakably gross

alteration in the appearance of spine, pelvis and sometimes femora and other long bones.

The pelvic cortex is paper-thin, the trabeculae are seen as a faint network of extremely fine lines and there are apt to be multiple fractures of the pelvic bones. Because of the softness of the bone these fractures lack the angular, brittle appearance of a traumatized pelvis of normal density and the lesions are better described as a crumpling of the pelvis.

DISTRIBUTION

The "osteomalacia areas" described in the Western Europe of two decades ago and considered proof of the relationship between this disease and local conditions of food, water or exposure to infection are little talked of today, and the earlier belief that there were similar sharply restricted disease zones in India and China is falling before the modern conception that the disease occurs whenever and wherever conditions of light and vitamin D deficiency in the presence of increased calcium demand are sufficiently unfavorable.

THE DISEASE IN ANIMALS

In the course of methodical studies on the relationship between food intake and the farm production of milk, eggs and meat, Steenbock⁵⁶ in 1912 took up the study of the rôle of lime in the diet. He knew that pregnant animals lost calcium in the urine and feces and that it collected in the meconium of their fetuses and he was curious as to why these animals did not reabsorb the calcium and retain it. He was not at all impressed with the prevailing ideas that the fecal calcium was not in a suitable chemical state for reabsorption but postulated rather that the passage of calcium into the intestine was a normal affair and that for some reason pregnancy interfered with the organism's ability to reabsorb and utilize the calcium, as he supposed was probably done in the normal nonpregnant or nonlactating state. (We now know that this is

the case—that an animal ingesting barely enough vitamin D for her own metabolic needs will supply a portion of this to her fetus, thus becoming deficient herself and therefore unable to accomplish adequate metabolism of calcium.) The work was begun by confining a cow to a metabolism cage, determining the exact amount of calcium in all forms in her diet and then reducing that calcium until an interference with metabolism occurred. This was followed shortly by a similar experiment with a lactating goat confined in a metabolism cage from April 4 to July 29, 1912, on a diet consisting of oat straw, wheat bran and meal from corn rice and gluten. This was gradually modified until by June 12 oat straw alone was being fed and the calcium content of the diet was rather low. The animal gradually showed signs of disturbed metabolism, lactation ceased, alertness was reduced and calcium was lost in the feces steadily. There were no clean-cut symptoms of osteomalacia and the stiffness of the hind quarters may have been due merely to confinement in the cage but Steenbock, whose experience ought to make him a competent judge, considered that a continuation of the experiment would have led to osteomalacia.

With the idea of allowing the animal a temporary respite, calcium intake was increased to the level used during the opening days of the experiment but surprisingly no improvement occurred and on the thirtieth of July it was deemed necessary to discontinue the experiment.

After two weeks of grazing on green grass with supplementary feedings of oats the animal was restored to apparently perfect health and Steenbock in this article, written before the publication of Funk and the work of Mellanby, reached conclusions, the essentials of which may be summarized as follows:*

This animal brought to a condition which would have led to osteomalacia has been completely restored to normal by a temporary

* Steenbock's actual words rearranged and condensed for brevity.

change in diet. That the change of intake of lime was responsible is out of the question. Some subtle variation in feed intake and environment now enables the animal to assimilate lime formerly unavailable. Just what these factors are we cannot venture to say.

The fowls reported by Marine³⁹ in 1914, Luce's³⁶ 1923 rats and Macomber's³⁸ 1927 rats were fed diets deficient in calcium and did not develop osteomalacia or rickets of the grade that Luce could see on examination by the naked eye or Macomber with the aid of roentgenographic examination. It must be remembered, however, that none of these animals or birds were deliberately deprived of sunlight and that the earlier ones at least had no control of the vitamin D content of their diet. It is hard to believe that no one has conducted the obvious experiment of holding pregnant monkeys on diets known to be capable of producing rickets in growing animals but we have been unable to find any record of such work.

White's 1922 article⁶⁴ on osteomalacia among monkeys in the Philadelphia Zoo impresses us as a pretty convincing illustration of the etiology of the disease.

RELATIONSHIP OF RICKETS TO OSTEOMALACIA

Most of the arguments against the identical nature of these diseases are based on negative evidence. It is claimed, for instance, that certain conditions of diet and light in China produce osteomalacia in a high percentage of child-bearing women but fail to produce rickets in children living under identical conditions. Indian women confined to dark quarters by the requirements of their religion and restricted to inadequate diet by poverty or ignorance suffer from osteomalacia but children said to be on diets at least as bad survive in the same community without acquiring rickets. Such arguments are easily attacked from two sides. First, the statement that conditions of diet and light are identical in any two cases can be accepted only after painstaking investigation. Second, a re-

port to the effect that this disease or that does not exist in a certain territory is usually worthless. Rickets "did not exist" in China until Franklin McLean in about 1920 put Ernest Tso to work looking for it. There is no dearth of Chinese rickets now.

FETAL RICKETS AND OSTEOMALACIA

Another stumbling block has been the supposed absence of instances of fetal rickets in children born by caesarean section from women suffering from active osteomalacia.

A low incidence of such cases would not be surprising because of the recognized ability of the fetus to obtain all of the materials necessary for its metabolism at the expense of the maternal organism. Occasional cases should be encountered, however, where the maternal metabolic deficiency is so severe that the fetus does not escape rachitic lesions. In 1929 there seemed to be no proved case of this sort but Maxwell, Hu and Turnbull⁴⁵ have recently described and illustrated a case of undoubted rickets in the caesarean child of a mother suffering from frank osteomalacia.

TREATMENT

The treatment of osteomalacia is the treatment of rickets—a diet adequate in all respects and particularly in vitamin D, plus an adequate amount of sunshine. Early failures to cure by this method are now recognized as due to the administration of an inadequate amount of cod-liver oil at a time when its biological standardization was not well understood. As Hess points out, blockaded central Europe in spite of the exigencies of war had close at hand all of the necessary medicines to cure the war osteomalacia. Yeast was available and sunlight, either natural or artificial, but at that time the human race had not learned to put the two together and thus produce a material essential in the metabolism of calcium. Future work may well demonstrate that diet deficiency depletes skeletal calcium through the agency of the

parathyroids but even if this can be shown to be true the fact remains that osteomalacia is primarily a disease manifestation of vitamin D deficiency.

REFERENCES

1. BARR, D. P., BULGER, H. A., and DIXON, H. H. Hyperparathyroidism. *J. Am. M. Ass.*, 1929, 92, 951-952.
2. BLUM, L., DELAVILLE, and VAN CAULAERT. Minerals in blood in osteomalacia. *Compt. rend. Soc. de biol.*, 1924, 91, 599-601. Abs. *J. Am. M. Ass.*, 1924, 83, 877.
3. BLUMGART, H. L., CARGILL, S. L., and GILLIGAN, D. R. Osteomalacia; a study of its metabolism and treatment. *Tr. Ass. Am. Physicians*, 1929, 44, 245-253.
4. BOYD, J. D., MILGRAM, J. E., and STEARNS, G. Clinical hyperparathyroidism. *J. Am. M. Ass.*, 1929, 93, 684-688.
5. BUCHHOLZ, E. Ueber Lichtbehandlung der Rachitis und anderer Kinderkrankheiten. *Verhandl. d. Versamml. d. Gesellsch. f. Kinderh. . . deutsch. Naturf. u. Aerzte*, 1905, 21, 116. Quoted by Park, ref. 52.
6. COMPERE, E. L. Bone changes in hyperparathyroidism. *Surg., Gynec. & Obst.*, 1930, 50, 783-794.
7. CROOKS, J. Two unusual examples of osteogenesis imperfecta. *Brit. M. J.*, 1932, 1, 705.
8. DALYELL, E. J., and CHICK, H. Hunger-osteomalacia in Vienna, 1920. I. Its relation to diet. *Lancet*, 1921, 2, 842-849.
9. DIECKMANN, W. J. Osteomalacia in pregnancy. *J. Missouri M. Ass.*, 1930, 27, 451-452.
10. DIECKMANN, W. J. Osteomalacia in pregnancy. *Am. J. Obst. & Gynec.*, 1932, 23, 478-488.
11. DOCK, GEORGE. Osler's Modern Medicine, Vol. 5, p. 859, Lea and Febiger, Philadelphia, 1927.
12. DRAGSTEDT, L. R. The physiology of the parathyroid glands. *Physiol. Rev.*, 1927, 7, 499-530.
13. DWYER, H. L., and ECKELBERRY, O. S. Osteomalacia in children; a study of the mineral metabolism. *Am. J. Dis. Child.*, 1926, 31, 639-653.
14. FINDLAY, L. Rickets, a historical note. *Glasgow M. J.*, 1919, 91, 147. Quoted by Park, ref. 52.
15. FINDLAY, L. A review of the work done by the Glasgow School on the aetiology of rickets. *Lancet*, 1922, 1, 825-831. Quoted by Park, ref. 52.
16. FINDLAY, L., PATON, D. N., and SHARPE, J. S. Studies in the metabolism of rickets. *Quart. J. M.*, 1920-1921, 14, 352.
17. FOWWEATHER, F. S. Some remarks on osteomalacia with special reference to a recent case. *Lancet*, 1926, 1, 1082-1083.
18. FUNK, C. Die Vitamine, ihre Bedeutung für die Physiologie und Pathologie. J. F. Bergmann, Wiesbaden, 1914. Quoted by Park, ref. 52.
19. GESCHICKTER, C. F., and COPELAND, M. M. Tumors of Bone. American Journal of Cancer, 1931, pp. 679-681.
20. GUY, C. C. Tumors of the parathyroid glands. *Surg., Gynec. & Obst.*, 1929, 48, 557-565.
21. VON HANSEMANN, D. Ueber Rachitis als Volkskrankheit. *Berl. klin. Wchnschr.*, 1906, 43, 249-254. Quoted by Park, ref. 52.
22. VON HANSEMANN, D. Der Einfluss der Domestikation auf die Krankheiten der Tiere und der Menschen. *Wien. med. Presse*, 1906, 47, 1130-1132. Abs. *Berl. klin. Wchnschr.*, 1906, 43, 629. Quoted by Park, ref. 52.
23. HESS, A. F. Rickets Including Osteomalacia and Tetany. Lea and Febiger, Philadelphia, 1929.
24. HOLMES, G. W. Osteomalacia; its roentgenographic appearance and classification. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1918, 5, 507-512.
25. HOPKINS, F. G. The analyst and the medical man. *Analyst*, 1906, 31, 385. Quoted by Park, ref. 52.
26. HOYLE, J. C. The relation of the parathyroid glands to disorders of bones. *Practitioner*, 1930, 124, 532-547.
27. HUGHES, T. A., SHRIVASTAVA, D. L., SAHAI, P. N., and MALIK, K. S. Further observations on the serum calcium and plasma cholesterol in health and disease and on the blood chemistry in osteomalacia. *Indian J. Med. Research*, 1930, 18, 517-526.
28. HULDSCHINSKY, K. Heilung von Rachitis durch künstliche Höhensonnen. *Deutsche med. Wchnschr.*, 1919, 45, 712.
29. HUME, E. M., and NIRENSTEIN, E. Comparative treatment of cases of hunger-osteomalacia in Vienna, 1920, as out-patients with cod-liver oil and plant oil. *Lancet*, 1921, 2, 849-853.
30. HUTCHISON, H. S., and STAPLETON, G. Late rickets and osteomalacia. *Brit. J. Child. Dis.*, 1924, 21, 18-33; 96-106.
31. KERL, F. Hyperplasia of the parathyroids in osteomalacia and osteoporosis. *Deutsche med. Wchnschr.*, 1925, 51, 1271-1273. Abs. *J. Am. M. Ass.*, 1925, 85, 936.
32. KNAGGS, R. L. On osteitis deformans (Paget's disease) and its relation to osteitis fibrosa and osteomalacia. *Brit. J. Surg.*, 1925-1926, 13, 206-237.
33. LAFFONT, A., and SESINI, M. L'ostéomalacie à la maternité d'Alger. *Rev. franc. de gynéc. et d'obst.*, 1930, 25, 430-434.

34. LOCKE, E. A. Osteomalacia (juvenile form). *Med. Clin. N. Am.*, 1923, 7, 687-704.
35. LOCKE, E. A. Osteomalacia. Oxford Medicine, Oxford University Press, 1927, p. 462.
36. LUCE, E. M. The size of the parathyroids of rats, and the effect of diet deficiency of calcium. *J. Pathol. & Bacteriol.*, 1923, 26, 200-206.
37. MACCALLUM, W. G. A Textbook of Pathology. Third edition. W. B. Saunders, Philadelphia.
38. MACOMBER, DONALD. Effect of a diet low in calcium on fertility, pregnancy and lactation in the rat. *J. Am. M. Ass.*, 1927, 88, 6-11.
39. MARINE, DAVID. Parathyroid hypertrophy and hyperplasia in fowls. *Proc. Soc. Exper. Biol.*, 1914, 11, 117.
40. MAXWELL, J. P. Osteomalacia in China. *China M. J.*, 1923, 37, 625-642.
41. MAXWELL, J. P. Osteomalacia in China. *China M. J.*, 1924, 38, 349.
42. MAXWELL, J. P. Further studies in osteomalacia. *Proc. Roy. Soc. Med. (Sect. Obst. & Gynaec.)*, 1930, 23, 19-32.
43. MAXWELL, J. P. Osteomalacia and foetal rickets. *Brit. J. Radiol.*, 1930, 3, 375-379.
44. MAXWELL, J. P., and MILES, L. M. Osteomalacia in China. *J. Obst. & Gynaec. Brit. Emp.*, 1925, 32, 433-473.
45. MAXWELL, J. P., HU, C. H., and TURNBULL, H. M. Foetal rickets. *J. Pathol. & Bacteriol.*, 1932, 35, 419-440.
46. MCCRUDDEN, F. H. Studies of bone metabolism, especially the pathological process, etiology and treatment of osteomalacia. *Arch. Int. Med.*, 1910, 5, 596-630.
47. MELLANBY, E. The part played by an "accessory factor" in the production of experimental rickets. *J. Physiol.*, 1918, 52, 11-12. (*Proc. Physiol. Soc. Jan. 26, 1918, p. xi.*)
48. MELLANBY, E. An experimental investigation on rickets. *Lancet*, 1919, 1, 407.
49. MELLANBY, E. Experimental Rickets. London, 1921, H. M. Stationary Office. (Privy Council. Med. Res. Council. Spec. Rep. Ser. No. 61.) Quoted by Park, ref. 52.
50. MILES, L. M., and FENG, C. T. Calcium and phosphorus metabolism in osteomalacia. *J. Exper. M.*, 1925, 41, 137-157.
51. PALM, T. A. The geographical distribution and aetiology of rickets. *Practitioner*, 1890, 45, 270-291; 321-342.
52. PARK, E. A. Etiology of rickets. *Physiol. Rev.*, 1923, 3, 106-163.
53. PILLEY, V. E. An x-ray study of osteomalacia. *Indian J. Med. Research*, 1929, 17, 348-350.
54. RICHARDSON, E. P., AUB, J. C., and BAUER, W. Parathyroidectomy in osteomalacia. *Ann. Surg.*, 1929, 90, 730-741.
55. STAPLETON, G. Late rickets and osteomalacia in Delhi. *Lancet*, 1925, 1, 1119-1123.
56. STEENBOCK, H., and HART, E. B. The influence of function on the lime requirements of animals. *J. Biol. Chem.*, 1912-1913, 14, 59-73.
57. STEENBOCK, H., and NELSON, E. M. Fat-soluble vitamins; light in its relation to ophthalmia and growth. *J. Biol. Chem.*, 1923, 56, 355-373.
58. STEENBOCK, H., HART, E. B., SELL, M. T., and JONES, J. H. The availability of calcium salts. *J. Biol. Chem.*, 1923, 56, 375-386.
59. STEENBOCK, H., and BLACK, A. Fat-soluble vitamins; the induction of growth-promoting and calcifying properties in a ration by exposure to ultra-violet light. *J. Biol. Chem.*, 1924, 61, 405-422.
60. STEENBOCK, H., BLACK, A., NELSON, E. M., NELSON, M. T., and HOPPERT, C. A. Anti-rachitic activation by light. *J. Biol. Chem.*, 1925, 63, xxv.
61. STONE, E. L. A brief review of the literature of osteomalacia with the report of a case necessitating delivery by caesarean section. *Surg., Gynec. & Obst.*, 1924, 39, 599-609.
62. TROUSSEAU, A. Lectures on Clinical Medicine. Translation by John Rose Cormack. The New Sydenham Society, London, 1872, Vol. V, p. 81.
63. VAUGHAN, K. Osteomalacia in Kashmir. *Brit. M. J.*, 1926, 1, 413-415.
64. WHITE, E. P. C. Osteomalacia. *Arch. Int. Med.*, 1922, 30, 620-628.
65. WILDER, R. M. Hyperparathyroidism; tumor of the parathyroid glands associated with osteitis fibrosa. *Endocrinology*, 1929, 13, 231-244.
66. WILSON, D. C. Osteomalacia (late rickets) studies; clinical symptoms in relation to bone changes as shown by x-ray examination. *Indian J. Med. Research*, 1929-1930, 17, 339-347.
67. WILSON, D. C., and COOMBES, W. K. Osteomalacia (late rickets) studies; factors in treatment. *Indian J. Med. Research*, 1930-1931, 18, 959-962.
68. WILSON, D. C., and PATEL, G. P. Osteomalacia (late rickets) studies; blood picture. *Indian J. Med. Research*, 1929-1930, 17, 881-887.
69. WILSON, D. C., and SURIE, E. Osteomalacia (late rickets) studies; dietary factors in the aetiology of osteomalacia. *Indian J. Med. Research*, 1930, 17, 889-902.
70. WYATT, H. G. Notes on osteomalacia in North China. *China M. J.*, 1930, 44, 1168-1182.

OSTEITIS FIBROSA CYSTICA

ASSOCIATED WITH PARATHYROID OVERACTIVITY*

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CASES of osteitis fibrosa cystica may be divided into two groups: first, those unassociated with an endocrine disturbance and usually of obscure etiology; second, those which are a manifestation of a systemic disease caused by overactivity of the parathyroid glands. This paper will deal only with the latter group.

It was shown first by MacCallum that hypofunction of the parathyroids resulted in tetany, the symptoms of which could be relieved by the administration of calcium. The fact that these glands exercise a control over calcium metabolism was thus established.

Overactivity of the parathyroids produces a condition which is the reverse of tetany. This is characterized by an increase in the calcium content of the blood, a lowering of the blood phosphorus, an increased elimination of calcium and phosphorus by the kidneys, and a decalcification of the bones. This condition can be produced experimentally in animals by the administration of parathyroid extract (parathormone) and is observed in man in certain cases of osteitis fibrosa cystica. It was not until 1926 that Mandl definitely established the relationship of parathyroid dysfunction to osteitis fibrosa cystica by the removal of a parathyroid adenoma. The operation was followed by a most remarkable improvement in the patient's condition. Since this pioneer work by Mandl an increasing number of similar cases successfully operated upon are appearing in the literature.

SYMPTOMS OF HYPERPARATHYROIDISM

The disease may occur at any age, and in either sex, but is most common in women between thirty and sixty. Most patients complain first of bone and joint pains which

they attribute to "rheumatism." In the advanced stages of the disease extensive skeletal deformities may develop as the result of softening, bending, and fracture of the bones. Gastrointestinal symptoms are not uncommon, such as loss of appetite, nausea, and occasionally vomiting. There is usually a slow, progressive loss of weight, and a secondary anemia. There may be a palpable tumor in the neck (parathyroid adenoma).

The urinary symptoms are important. There is impairment of renal function. Polyuria is frequently present, with low specific gravity, albumin, and casts. The increased output of calcium and phosphorus leads to the formation of urinary calculi, which may be bilateral. *Any abnormal rarefaction of one or more bones in a patient presenting a renal calculus should be regarded as suspicious of osteitis fibrosa cystica* (Case IV).

A correct determination of the blood calcium and phosphorus is essential to the diagnosis. The serum calcium is elevated (more than 10 mg. per 100 c.c.), and the serum inorganic phosphorus is low (less than 4 mg. per 100 c.c.).

PATHOLOGY

The skeletal changes are characterized by decalcification and cyst formation which have been described at length in an earlier article.² Specimens removed from the cystic areas give the microscopic appearance of benign giant cell tumor.

The parathyroid tumors which have been described vary in size from a few millimeters to 5 or 6 centimeters in diameter. The microscopic picture is that of an adenoma which may be difficult to differentiate from normal parathyroid tissue.

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Abnormal calcium deposits in the soft tissues have been described.

ROENTGEN FINDINGS

The skeletal changes are: (1) generalized bone decalcification together with localized areas of increased bone density; (2) generalized or localized cyst formation. It must be emphasized that not all cases present a typical picture. A generalized osteoporosis may be seen without cyst formation, and, conversely, cyst formation may occur without appreciable osteoporosis.

When the skull is involved the picture is fairly characteristic and should point the way to the correct diagnosis. The bones of the vault present a mottling which is the result of small, irregular areas of bone condensation alternating with areas of rarefaction. In advanced stages of the disease the cranial bones may become much thickened. The upper and lower jaws are both favorite sites for cyst formation. The teeth are often carious and abscessed.

The spine may show abnormal curvatures which become more pronounced as the disease progresses. There is narrowing of the vertebral bodies with an alteration in bony texture and a tendency toward concavity of the articular surfaces. The intervertebral spaces are not narrowed and the vertebral processes do not appear abnormal.

The pelvis is frequently the site of very extensive cystic changes, and abnormalities of contour develop as the weakened bones give way to the body weight.

The ribs are quite regularly involved in the cystic process, and late in the disease there may be a caving in of the thorax with serious cardiac and respiratory embarrassment.

Cysts occur in all the long bones and in the bones of the hands and feet. The bones may become expanded and the cysts trabeculated, giving the appearance of a giant cell tumor, or there may be localized areas in which there is a complete loss of bone trabeculae, but without expansion or other alteration in the contour of the bone. In a

boy of fifteen there were observed areas of increased bone density about 1 cm. in diameter extending across the diaphyses just back of the epiphyseal lines. Adjacent to these bands of condensation were areas of superficial cortical erosion. Slipping of the epiphyses has been reported in young individuals. Fractures of the extremities are common and seem to heal readily, but without excess of callus. A cyst which has been the site of spontaneous fracture or surgical interference will often regress rapidly.

Films of the abdomen show renal calculi in a large percentage of cases. These are frequently bilateral. Varying degrees of hydronephrosis are demonstrable in pyelograms.

The calcium deposits which have been described post mortem in the lungs and other viscera should be demonstrable by roentgen examination, but we have not observed them in our series.

It is our opinion that too sharp a distinction should not be drawn between localized and generalized osteitis fibrosa cystica. One of our cases presents a localized cystic change in one ilium, a renal calculus, an elevated blood calcium, and a low blood phosphorus. There are no cysts elsewhere in the skeleton, and there is no evidence whatever of generalized osteoporosis. This patient undoubtedly has hyperparathyroidism, the only roentgen evidence of which is a renal stone and a single cyst.

DIFFERENTIAL DIAGNOSIS

Two cases of multiple myeloma have recently come to our attention presenting bone changes which might easily be confused with those of osteitis fibrosa cystica. Both cases, however, presented a normal blood calcium and phosphorus and the removal of a specimen of bone established a diagnosis of myeloma beyond question.

Jores reports 2 cases of multiple myeloma showing elevation of blood calcium. In one of these cases the blood phosphorus was at first normal and later became lowered. In the second case the phosphorus was normal.

It becomes evident that the differentiation between osteitis fibrosa cystica and multiple myeloma may occasionally be extremely difficult without a pathological examination. We should recommend that a biopsy be taken from the bone whenever it is feasible.

TREATMENT

In those cases presenting a palpable adenoma of the parathyroid the surgical removal of the tumor is usually simple and is followed promptly by a return of the calcium and phosphorus balance to normal, with a rapid improvement in the patient's condition (Cases I and V). When there is no tumor felt in the neck, an exploratory operation is justifiable provided the diagnosis of hyperparathyroidism has been established beyond doubt. Such operations are occasionally unsuccessful, even when carried out by the most competent surgeons (Cases II and III). For the operative technique one should refer to the article by Hunter and Turnbull.

Albright et al. have obtained encouraging results by the administration of large amounts of phosphate. They state that, "The net result of ingestion of phosphate in hyperparathyroidism is the tendency to produce a positive balance of calcium phosphate and the altering of the serum calcium and phosphorus values in the direction of normal." They point out, however, that there are two real dangers associated with phosphate ingestion in hyperparathyroidism; first, a shut down of kidney function; second, an increased tendency toward the formation of urinary calculi.

High voltage roentgen irradiation has proved highly efficacious in relieving the pain in one of our cases (Case IV), and may have had something to do with the improvement noted in Case II. In our experience, irradiation must still be considered as a palliative measure only in this disease.

CASE I. (Memorial No. 11616. Baker No. 1423.) (Previously reported.) Female, aged forty-four, white, married; first seen in September, 1930.

The patient complained of rheumatism with pain and swelling of the right forearm. There had been a slow loss of strength for a period of several years with more or less generalized "rheumatic" pains. In the past two years she had lost 20 pounds in weight. For two months she had frequency of urination. Fourteen years ago she first noticed a swelling in the region of the thyroid on the right side. The salient point of the physical examination was a palpable mass in the region of the right lobe of the thyroid. Roentgen examination showed an extensive osteitis fibrosa cystica of the skull, spine, ribs, pelvis, and bones of the extremities. There were no renal calculi. There was a spontaneous fracture through a cyst in the right ulna. The blood calcium was 11 mg. per 100 c.c., and the blood phosphorus 2.3 mg. per 100 c.c. The specimen removed from the cyst in the ulna for microscopic examination showed the picture of benign giant cell tumor.

The patient was operated on in December, 1930, and a large parathyroid adenoma removed, measuring about 6 cm. in diameter. Following the operation the blood calcium and phosphorus returned to normal. At the present writing the patient is symptomatically well. A recent roentgen examination of the skeleton shows that there is still some osteoporosis and that the cysts are very little changed in appearance, with the exception of the one in the ulna which has almost completely healed.

CASE II. (M.G.H. No. 184237. Baker No. 7727.) Female, aged forty-one, white, married. (Previously reported.) Admitted to the Massachusetts General Hospital in July, 1930, with the complaint of rheumatism.

The present illness began five years previously, following the birth of the fifth child. There was weakness and pain in the back and knees. This became progressively worse until patient finally had to get about on crutches. She suffered a fracture of the hip and of the arm.

Physical examination showed general muscular weakness and tenderness on pressure of practically all the bones. Examination of the blood showed a secondary anemia. Urine examination showed a low specific gravity with albumin and many white blood cells. The blood serum calcium was elevated to 13.5 mg. per 100 c.c. and the blood phosphorus was 2.16 mg. per 100 c.c. Roentgen examination showed a generalized osteitis fibrosa cystica involving the

skull, spine, pelvis, shoulder girdles, ribs, and bones of the extremities. There were bilateral renal calculi and bilateral hydronephrosis. The patient was operated on in September, 1930, and the two lower parathyroid glands removed. These glands were not abnormal on histological examination and there was no evidence of adenoma. Following the operation there was no appreciable change in the patient's general condition. The blood calcium remained high and the phosphorus low. Patient was then given high voltage roentgen irradiation to the neck, and was put on a dietary regimen (high phosphate ingestion) which has been described by Albright and his coworkers. Follow-up roentgen examinations showed some deposition of lime salt in the bones and a tendency toward filling in of the cystic areas. The patient also obtained some symptomatic relief. There has been a progressive impairment of renal function and the patient has just been admitted to the Massachusetts General Hospital for a second surgical exploration of the neck.

CASE III. (Memorial No. 13727.) Female, aged thirty-five, white, married.

The patient was referred for roentgen examination in October, 1931, with the complaint of rheumatism in the left hip. In 1926 the patient noticed pain in the left arm especially in damp weather. This continued off and on until 1930, when suddenly she could not lift her arm. The disability gradually cleared up and now she notices only pain and a tired feeling in the arm on damp days. In 1926, there was a question of an abscess in the throat. There was considerable swelling thought to be connected with the thyroid until pus was discharged and the swelling disappeared. In January, 1931, the patient fell on the ice striking on the left buttock. She was able to walk home, but remained lame and sore for two weeks. The lameness recurred every few days and the leg felt very tired. During the last three months the lameness has increased and the patient feels as if she had no strength in the left leg. During the past month the patient has noticed a swelling of the left lower jaw which she attributes to an ulcerated tooth. The family history is not remarkable. There is nothing of particular importance in the past history. The patient was pregnant about four years ago, but had a miscarriage. There have been no other pregnancies or miscarriages.

Physical examination. The eyes, ears and nose are negative. The teeth are in poor condi-

tion. There is a noticeable swelling of the left mandible which is slightly tender on pressure. The throat is a little injected. There are no masses palpable anywhere in the neck. The chest is negative to percussion and auscultation. The heart sounds are regular and of good quality. The blood pressure is 130/100. There is some soreness on pressure over the upper portion of the left thigh. The extremities are otherwise not remarkable. Present weight 141 pounds. Weight six months ago, 154 pounds.

Roentgen examination of the entire skeleton. There is general rarefaction of all the bones with cyst formation in the wing of the right ilium and in the left ilium adjacent to the acetabulum. There is also a large cyst in the upper end of the left humerus and a smaller one in the right humerus. There is a cystic area in the left patella. There is slight roughening along the margins of the terminal phalanges of the fingers. Examination of the jaws shows multiple apical abscesses and a large cystic area of bone destruction in the left mandible. The skull presents fine mottled areas of decreased density interspersed with areas of increased density throughout the bones of the vault. A film of the chest is negative. A flat film of the abdomen shows no evidence of renal calculi. The findings are those of osteitis fibrosa cystica which is probably dependent on a hyperparathyroidism. The patient should have blood calcium and phosphorus studies.

Blood calcium, 14.1 mg. per 100 c.c. Blood phosphorus, 2.9 mg. per 100 c.c. Other laboratory examinations not remarkable.

On October 19, an exploration of the neck for parathyroid tumor was carried out. A transverse incision was made across the base of the neck and the skin dissected back to give ample room for thyroid dissection. The facial layer was incised longitudinally and the right lobe of the thyroid exposed. The thyroid gland was then gradually dissected out from its base and the lower pole of the right lobe was turned up and a search for the parathyroid made. There came into view a small tumor about 1 cm. in diameter. This was entirely separate from the thyroid with a pedicle and a capsule of its own, and seemed to be unquestionably the pathological parathyroid. This was easily separated from its surrounding tissue, its pedicle clamped off and cut away.

Microscopic examination of the tissue removed showed an aberrant lobe of the thyroid

gland. There was no evidence of parathyroid tissue in the specimen. Following operation the patient showed slight symptomatic improvement and there was a temporary fall in the blood calcium.

She was again admitted to the hospital in April, 1932, symptomatically very much worse. Blood calcium was 21 mg. per 100 c.c., blood phosphorus 2.0 mg. per 100 c.c. A biopsy from the cystic area in the mandible was taken which showed the microscopic picture of benign giant cell tumor, thus confirming the diagnosis of osteitis fibrosa cystica beyond question. A second exploration of the neck was carried out in May, 1932, but no parathyroid tumor was found. Following the operation the blood calcium remained elevated to 14.4 mg. per 100 c.c. and the phosphorus was lowered, 3.1 mg. per 100 c.c.

The patient was not seen again until September, 1932. At this time she complained of severe pain in the left shoulder and in the left hip. She walked with extreme difficulty and stated that she spent most of her time sitting or lying down. High voltage roentgen treatment was instituted giving 700 r to the anterior neck, 600 r to the left shoulder and 600 r over the left hip. At the completion of the series there was no appreciable change in the patient's condition.

CASE IV. (Huntington No. 32:291.) Female, aged, forty-four, single.

Patient first came under observation in March, 1932, with the complaint of pain in the right hip. This had been present for about five months and had become very severe at times. Patient walked with a considerable limp and used a cane. Her general health was otherwise excellent. She had a cholecystectomy fifteen years ago at which time gallstones were found. She had an anal fistula operated upon twice, once sixteen years ago and once a year ago. Her appetite has been good. The bowels have been regular and there have been no urinary symptoms. Menses have been regular. She has had no dyspnea or edema. When she was about nineteen years old she suffered from bronchitis and asthma, but this cleared up following injections which a doctor in New York gave her. The family history is negative.

Physical examination shows an obese woman of middle age. Head is normal. Eyes are negative. Fundi are normal with slightly more than average pigmentation. Mouth: Upper teeth false. Lower teeth are mostly false. Oral hygiene

is good. Tonsils are enlarged and ragged in appearance. Pharynx is slightly red. One or two pea-sized lymph nodes are palpable in the right submaxillary region. Except for this the neck is negative. Deep palpation in the region of the thyroid reveals no evidence of tumor. Chest is normal externally. Breasts negative. Lungs are clear to percussion and auscultation. Heart borders cannot be made out because of obesity. Sounds are of fairly good quality and intensity. Rhythm is regular. No murmur is audible. Blood pressure 140/90. Abdomen is negative except for a right rectus incision scar through which the gallbladder was removed. Rectal examination shows scars of operations for fistula which are well healed. There is a slight, red, raised area at the right side of the rectum which may be the beginning of another fistula. Internally there is nothing abnormal felt. Extremities and reflexes are normal.

Urine examination: Sp. Gr. 1.022; acid; sugar, negative; albumin, trace; many white blood cells; few red blood cells; no casts.

Roentgen examination of the pelvis shows an extensive area of bone destruction involving the greater portion of the right ilium. The cortex of the bone is intact and there is no expansion of the bone. The area of destruction shows slight mottling and trabeculation. Flat film of the abdomen shows a right renal calculus, which finding is corroborated by ureteral catheterization. Film of the chest is negative. Films of the entire skeleton show no other abnormalities. There is no decalcification of the bones except the area described in the ilium.

Because of the presence of a renal calculus the possibility of cystic disease in the ilium was considered and blood calcium and phosphorus determinations were carried out by Dr. Joseph C. Aub. The blood serum calcium was found elevated to 13.5 mg. and the blood phosphorus was lowered to 1.7 mg. per 100 c.c.

The patient was given high voltage roentgen therapy to the right hip in the hope of relieving the pain. A total of 600 r was given posteriorly and 400 r anteriorly. About a month following the treatments the pain disappeared entirely and it has not returned. She walks perfectly normally without the use of a cane. The irradiation was sufficient to produce cessation of menstruation. Temporarily following irradiation the blood calcium returned to normal, but since has again become elevated. The question of exploration for a parathyroid tumor is being con-

sidered, although there is no mass palpable in the neck.

CASE V. (Huntington No. 32:599.) Male, aged fifteen; first seen by us in May, 1932.

At the age of three years the patient had a severe attack of whooping cough and the mother states that the boy has never been well since. The present illness apparently started three years ago with a severe attack of erysipelas. At this time pain in the ankles and various parts of the body developed. The patient vomited a great deal following the erysipelas and there has been more or less nausea and vomiting since. The patient seems to suffer from general weakness and there is no spring to his muscles. When he walks upstairs he pulls himself up by his hands. About a year ago he began to drink large amounts of water and at this time a rather pronounced polyuria began. The appetite is poor. The bowels are fairly regular. Patient becomes easily fatigued and is short of breath. He has had no edema of the ankles. No cough. There has been no loss of weight recently, but during the past three years there has been practically no gain in weight. Two months ago the patient's mother noticed that the right side of his face was swollen. The patient was taken to the Deaconess Hospital where one of the upper right teeth was removed and a growth on the upper jaw curetted. This returned and was again removed after about two weeks. The right antrum was also cleaned out at this time. The diagnosis was epulis. The patient has attained the second year in high school in spite of much illness. The past history and family history are not remarkable.

Physical examination. The most striking thing about this patient is the disproportion of length of body and legs. The lower extremities are extremely long when compared with the trunk. He is quite thin and emaciated. The muscular development is poor. In spite of this his posture is not so bad as might be expected. The eyes are normal externally. Pupils are equal and react to light. Oral hygiene is good. Tonsils are not enlarged. There is a slight mucopurulent post-nasal drip. There are no lymph nodes enlarged in the neck, axillae, or groins. There is a mass $4 \times 4 \times 2$ cm. at the left of the thyroid cartilage and upper part of the trachea. This mass is quite easily visible as well as palpable. The external aspect of the chest shows moderate beading of the costochondral junctions. All of the attachments of the diaphragm to the ribs

can easily be detected by slight deformity. The relative cardiac dullness is not increased. The cardiac apex is palpable 6 cm. to the left of the midline in the 5th interspace 2 cm. within the mid-clavicular line. Sounds are of fair quality and intensity. The first sound at the apex is slightly roughened. The pulmonic and aortic second sounds are equal. There is a slight sinus arrhythmia present. Blood pressure 135/80. The lungs are clear to percussion and auscultation. The liver and spleen are not palpable. There are no abdominal masses felt. There is no tenderness over the long bones, but there is slight tenderness over the spine. The only deformity present is that of the ribs. The reflexes are normal.

Roentgen examination. The first roentgen studies were carried out by Dr. Merrill C. Sosman at the Peter Bent Brigham Hospital. The report is as follows: Examination of the skull presents a uniform, coarse mottling of all the bones, apparently with marked decalcification. There are several small, clear areas in the bone suggesting small cysts. There are no other localized changes and no signs of pressure. The clinoids are atrophic, but the pituitary fossa is otherwise normal. There is an irregular cystic area around the left lower second bicuspid. There is definite clouding of the right antrum. Films of the chest show abnormal bone, deficient in calcium with indefinite changes in the epiphyses but no definite cysts. The lungs are essentially normal. The findings strongly suggest the osteoporosis associated with a hyperparathyroidism. This could be confirmed by finding a high blood calcium. Further examination, including films of the spine and pelvis and all the long bones, presents a remarkable picture of a diffuse uniform osteoporosis, finely mottled in appearance so that the bones look like a sieve. This is uniform throughout the bone with the exception of the ends of the diaphyses where there is condensation of the bone and loss of structure. In the vertebrae there is condensation just under the vertebral plate so that the bodies present a rather hollow appearance. Many of the bones show areas of erosion just proximal to the condensed areas at the epiphyseal lines with new bone formation suggesting periostitis. This is particularly well shown in the upper ends of the humeri. Some of the epiphyses are abnormal, particularly those in the lower ends of the radii. There are no definite cysts seen. There are no renal calculi visible.

The findings are most probably due to the osteoporosis of hyperparathyroidism.

The patient was referred to Dr. Joseph C. Aub at the Huntington Hospital for calcium studies. The blood calcium and phosphorus determinations were as follows: Calcium 19.4 mg. per 100 c.c. Phosphorus 4.0 mg. per 100 c.c. Other laboratory studies as follows: Urine—clear; Sp. Gr. 1.005; neutral litmus reaction; no sugar; trace of albumin; moderate number of pus cells; a few granular casts. Blood: red blood cells, 3,610,000; white blood cells, 11,600; Hb. 65 per cent. Differential: polymorphonuclears, 59 per cent; polymorphonuclears, young, 5 per cent; eosinophils, 2 per cent; small lymphocytes, 23 per cent; large lymphocytes, 7 per cent; atypical lymphocytes, 1 per cent; mononuclears, 2 per cent; myelocytic neutrophils, 1 per cent. Phenolphthalein renal test, total output 35 per cent.

Films of the entire skeleton made by us confirmed in all respects the findings reported by Dr. Sosman.

Following these studies the patient was again

referred to the Peter Bent Brigham Hospital and on June 4, 1932, an adenoma of the left parathyroid was removed. Following the operation the blood calcium fell to 9.0 mg. per 100 c.c., and the phosphorus determination was 2.6 mg. per 100 c.c.

On July 18 the patient returned for observation. He has gained 5 pounds since he left the hospital and feels much better. He is able to walk and exercise as he never did before. He is able to jump on his toes and walk on his heels without any pain.

On September 8, the patient returned for further metabolic study. There has been a surprising improvement since his discharge. He has gained over 20 lb. in weight. The polyuria has ceased. There is no longer any pain or discomfort on walking. The operative scar in the neck is well healed. The physical examination is entirely negative.

Material for this publication has been collected from the Massachusetts General Hospital, the Worcester Memorial Hospital, and the Huntington Memorial Hospital.

REFERENCES

1. ALBRIGHT, F., BAUER, W., CLAFLIN, D., and COCKRILL, J. R. Studies in parathyroid physiology; effect of phosphate ingestion in clinical hyperparathyroidism. *J. Clin. Investigation*, 1932, *11*, 411-435.
2. DRESSER, R., and HAMPTON, A. O. Osteitis fibrosa cystica generalisata with hyperparathyroidism as etiology. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1931, *25*, 739-748.
3. HUNTER, D., and TURNBULL, H. M. Hyperparathyroidism; generalized osteitis fibrosa, with observations upon the bones, parathyroid tumours, and normal parathyroid glands. *Brit. J. Surg.*, 1931, *19*, 203-284.
4. JORES, A. Beitrag zur Differentialdiagnose des multiplen Myeloms und der Ostitis fibrosa generalisata mit besonderer Berücksichtigung des Kalkstoffwechsels. *Klin. Wchnschr.*, 1931, *10*, 2352-54.

DISCUSSION

DR. P. F. MORSE, Detroit, Mich. There are several points in Dr. Dresser's systematic dissertation that I think might well be emphasized and repeated because they seem to be of such clinical importance. He spoke of the localized and generalized cysts, and said that he did not think there should be too sharp a line drawn between those two conditions. That is a very important statement. We have run across it many times, especially in industrial accident cases. A patient will come in with a fracture of a bone in the foot or the hand. The roentgenologist will find that it is a pathological fracture that has passed through a single cyst and, without further investigation, will assume that it is merely an accidental cyst and that it has no general constitutional importance. Very often further examination of that patient will prove

that it is really a case of parathyroidism, and the industrial accident will not improve until the general condition of parathyroidism is taken care of.

I was very much interested in his remarks about multiple myeloma of the bone, especially since we have come to our own conclusion that multiple myeloma of the bone merely represents a malignant end stage of osteitis fibrosa cystica. In the diffused general types of osteitis fibrosa cystica we have found that we can practically never make a positive diagnosis without biopsy. You can do all the things that you usually do, and still you are in doubt until you have a biopsy. The biopsy will often reveal the multiple myeloma when you cannot positively state it to be such upon purely roentgenological or other grounds.

Our cases have been rather uniform in showing a high blood calcium and low blood phosphorus, and most of all a lengthened chronaxie. Those are the three things that we regard as most important characteristics of parathyroidism, of course, outside of the roentgen findings, so that Dr. Dresser's remarks bring special emphasis upon an implied close relation between osteitis fibrosa cystica and multiple myeloma, at least those of the so-called plasma-cell type.

I was very much interested in his remarks regarding Albright's work of a high phosphate diet in some of these conditions. We have had no experience with the high phosphate feeding in any of our cases, but we feel very definitely that the finding of a parathyroid neoplasm is distinctly not necessary. We went through that in goiter work, we went through it in endocrine surgery in general, and the same thing applies to parathyroid work. You can have hyperac-

tivity without obvious macroscopical or microscopical changes which can be definitely interpreted as a variation from normal, but those changes are sometimes remarkably small and often debatable, but the proof is in the clinical result. When these patients have not left their beds for two or three or four months, or have not been able to walk for a long time, and when they have been entirely incapacitated, and then after the removal of what might reasonably have been called grossly and also microscopically a couple of normal parathyroid bodies, they return to their work, and throw away their crutches, you have to be guided by clinical experience. So I do not think we should stick too closely to the dictum that there must be a parathyroid tumor or an enlarged parathyroid. We apparently will have to accumulate a little more experience before we can be sure in this matter.



GIANT CELL BONE TUMOR*

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THE characteristics by which giant cell bone tumor may be identified as a pathologic entity have been restricted little since Nélaton's thesis of 1860. There has been some tendency to separate those tumors occurring in the maxilla from those of the extremities as a group. The nomenclature has been modified by the general acknowledgment that "sarcoma" is a misnomer for this lesion. On the other hand, malignant change, or concurrent bone malignancy, has been observed. For that reason, and the tendency of the tissue to become less controlled in growth pattern after repeated disturbance, the term "benign," in our opinion, is also inappropriate as misleading.

Structurally, giant cell bone tumor appears as an isolated, circumscribed, expansile new growth in bone, near the end of the diaphyseal portion. The tumor is usually trabeculated. As much of the bony structure as contains sufficient calcium to be visible on the roentgenogram appears well organized, the areas between trabeculae representing the soft giant cell masses and their supporting fibroblastic and spindle cell stroma. The predominant histologic component is the bone tumor giant cell, of varying size, and containing multiple, centrally grouped nuclei. These giant cells possibly arise from the endothelium of the abundant capillary blood supply in the spindle cell stroma. They bear a close resemblance to the osteoclasts, and may be found in the lacunae of the osteoid and osseous tissue of the trabeculae. The disposition of these masses of giant cells between the trabeculae has been indicated above. In some, hemorrhagic cystic areas lined by these giant cells lie between trabeculae giving rise to the description as "bone aneurysm." The bone cortex about

the tumor may become actually paper thin, giving rise to the "egg-shell crepitus" on palpation, or entirely lacking in calcium as visualized on the roentgenogram. There is rarely invasion of the surrounding soft tissue. This may occur after an injury sufficient to fracture the cortex, or rupture the periosteal capsule. In our series the growing cartilage disc of the epiphysis was not invaded if the neoplasm appeared during the growing period. But after completion of growth and ossification of the disc, the bone of the epiphyseal end of the shaft is readily involved.

We have previously discussed the several theories of origin of this tumor.⁸ The preponderance of evidence favors a normal constituent of bone as a source for the predominant cell. The proliferation with resultant development of such a tumor is probably a response to local trauma. This may be in the nature of a hemorrhagic osteitis, a bizarre organization of pre-callus, or a reversion of the proliferating bone cells toward fetal connective tissue. There is a local withdrawal of calcium, and retardation of the normal osteoblastic reparative proliferation, but with some attempt to form capsular and trabecular bone about the growing giant cell masses.

In our series there seems to be some relation between size of giant cell, age of the process, and age of the patient. The younger the patient, and the shorter the interval since onset of known abnormality, the larger the giant cells. Also, the cell contour seems at times to suggest almost a syncytial character, as though the giant cell had grown by fusion, or mitosis without fission of cytoplasm.

The cystic areas are most logically considered as of hemorrhage into the tumor with subsequent liquefaction, rather than

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an essential cystic change of the bone. The remainder of the shaft of the affected bone shows no fibrotic degeneration.

In further consideration of the source of the bone tumor giant cell and the method of production of the tumor mass, the cystic areas of osteitis fibrosa cystica resemble closely in architecture the cystic and aneurysmal areas found in giant cell bone tumor. In both lesions the balance between bone formation and bone destruction is disturbed. In osteitis fibrosa generalisata the reformation of bone after demineralization is largely on the foundation of what appears to be a degenerative fibrous matrix. But there is apparently constitutional involvement, a true malacia. Giant cell bone tumor, on the other hand, is a local process of focal demineralization, and when bone is reformed in such an area does not show a fibrous matrix.

Giant cell bone tumor does not show the constitutional signs and symptoms (notably hypotonia, hypercalcemia, hypercalcuria, and deformity) of osteitis fibrosa cystica. It further exhibits a tendency to become locally malignant upon repeated insult.

There have been reported recently 3 cases of giant cell tumor of bone with concurrent parathyroid adenoma. These however were not isolated lesions. Each of these 3 patients had either multiple cystic areas (Pfahler) or an osteitis fibrosa generalisata with one prominent tumorous area, and the serum calcium changes associated with parathyroidism (Wilder, Barr et al).

Roentgen therapy is almost specific in its ability to induce ossification of giant cell tumor. I have observed the areas of cystic degeneration and of malacic fracture in osteitis fibrosa cystica to repair readily under roentgen therapy with no treatment of a possible parathyroid abnormality. Pfahler's case with multiple cystic bone tumors improved under roentgen therapy and removal of a parathyroid adenoma. Wilder's patient demonstrated regression of a tumor of the maxilla after removal of a

parathyroid adenoma. There has been no report on Barr's case since operation.

It is perhaps possible that the parathyroid gland is one of the sources of control—not directly upon calcium utilization in the body—but upon the "myeloplaxique" or osteoclastic components of bone. The secretion of a hyperplastic or adenomatous parathyroid may induce the extensive destruction of bone by excess stimulus of the "myeloplaques" with resultant hypercalcemia and hypercalcuria.

The constitutional reaction in parathyroidism is due possibly to the excess calcium mobilization which results from an overactivity of the osteolytic elements rather than the inability of the osteoblastic components to fix calcium.

It is also possible that the parathyroid acts as a check valve on the pituitary and other glandular elements in the control of skeletal growth. A slight imbalance between parathyroid and pituitary secretion might contribute to the giant cell tumor type of response to local bone injury. If this were the situation, the constitutional manifestations would probably be lacking because of the small discard of bone calcium from so localized a lesion. Further, the giant cell tumor under such circumstances would not respond adequately to roentgen therapy.

I was asked to include leontiasis ossium for this symposium. I have had no personal experience with this disturbance, and hence prefer to discuss it only by analogy. The local lesions of "leontiasis ossium" suggest somewhat the type of overgrowth seen in the mandible in the acromegalic, with a further proliferative osteitis. This may be, as suggested above in the case of giant cell bone tumor, a manifestation of imbalance of pituitary-thyroid-parathyroid ratio in a localized or minimal form, but in the reverse direction.

In conclusion, I do not feel that the evidence is sufficient at the present time to place giant cell tumor in the group of "primary parathyroid osteomalacias."

REFERENCES

1. BALLIN, M., and MORSE, P. F. Parathyroidism. *Am. J. Surg.*, 1931, 12, 403-416.
2. BALLIN, M., and MORSE, P. F. Parathyroidism and parathyroidectomy. *Ann. Surg.*, 1931, 94, 592-609.
3. BARR, D. P., BULGER, H. A., and DIXON, H. H. Hyperparathyroidism. *J. Am. M. Ass.*, 1929, 92, 951-952.
4. BOYD, J. D., MILGRAM, J. E., and STEARNS, G. Clinical hyperparathyroidism. *J. Am. M. Ass.*, 1929, 93, 684-688.
5. HUNTER, D. Hyperparathyroidism. (Hyperfunction of parathyroid tumour in case of generalized osteitis fibrosa.) *Proc. Roy. Soc. Med. (Sect. Med.)*, 1929, 23, 27-34.
6. HUNTER, D. Goulstonian lectures entitled significance to clinical medicine of studies in calcium and phosphorus metabolism. *Lancet*, 1930, 1, 897; 947; 999.
7. KLEMPERER, PAUL. Parathyroid hyperplasia and bone destruction in generalized carcinomatosis. *Surg., Gynec. & Obst.*, 1923, 36, 11.
8. PEIRCE, CARLETON B. Giant-cell bone tumor. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 28, 167-188.
9. SNAPPER, I. Parathyroid tumor and changes of the bones. *Arch. Int. Med.*, 1930, 46, 506-523.
10. WILDER, R. M. Hyperparathyroidism; tumor of the parathyroid glands associated with osteitis fibrosa. *Endocrinology*, 1929, 13, 231-244.

DISCUSSION

DR. MAX BALLIN, Detroit, Mich. Dr. Peirce is absolutely right that there are some giant cell tumors that do not belong to the parathyroid group. All we wanted to show up to now is that a good many of the giant cell tumors are of this origin. A monostotic cyst seems to be rare; if patients with seemingly solitary cysts are studied for calcium and phosphorus chemistry and a general survey of the skeleton is made one will be surprised how many of them show more symptoms of parathyroidism as foci of osteitis fibrosa cystica, hypercalcemia, and so on. At autopsy cases with monostotic processes have gross and microscopical changes all over the skeleton (Ask-Upmark and others).

The important pathological suggestion to be considered is that there seems to be a whole class of tumors of neoplastic formations that have intimate connection with endocrine, parathyroidal pathology and can frequently be arrested by removal of adenomatous or hyperplastic parathyroids.

Three amputations of limbs for such giant cell tumors have been described in the literature: for instance, in Beck's case a leg was amputated three years before a parathyroid tumor was found, no doubt the cause of the giant cell tumor described, for which the amputation was done. We have already mentioned the pitiful case of an English surgeon who amputated one leg on account of a decalcified mass around a femoral fracture being considered malignant and recognized the parathyroid origin of this affection only when the same process arose in the remaining leg. Here it was cured by removal of a parathyroid tumor. If a few such cases are

recorded by courageous men many more have occurred without being given publicity.

Likewise the giant cell tumors of the jaw have an etiological connection with parathyroidism. Barr and Bulger have published such a case, a slide of which is shown here, with giant cell tumors proved by biopsy permeating the mandible, that did not get better from curetting and so forth, but disappeared after parathyroidectomy.

Here is another slide showing practically total disappearance of the jaw. The total decalcification came on gradually without any special reason. This film was sent to us for an opinion as to the possible parathyroidal origin of the affection; it certainly resembles the femur and the pelvic slides where all contour has disappeared, in the case of parathyroid adenoma (Hunter, Ballin, Morse, et al.)

Again a slide of a woman who, fifteen years ago, went to Holland on account of a tumor of the maxilla; the jaw was resected for the diagnosis of sarcoma. She came back to us after a year with the loss of half of her maxilla but the process had extended to the other side of the maxilla. That was at least fourteen years ago and she is still robust in spite of this "sarcoma." Later on a general roentgen check-up showed osteitis fibrosa cystica of the skull and pelvis. Furthermore, her brother and one sister have the same roentgenological changes through their skeletons. Hereditary factors are mentioned several times in parathyroid literature.

A few more slides show how giant cell sarcomas disappear immediately after parathyroidectomy.

tomy (Hunter, Ballin, Morse, Léri, and others).

In conclusion it seems to be our duty in all giant cell tumors of the skeleton, also of the jaws, to exclude the possibility of parathyroid origin to avoid unnecessary operations on bones and curetting, not to speak again about resection and amputations, if the removal of a parathyroid tumor can establish cures as has now been shown so often.

DR. P. F. MORSE, Detroit, Mich. The question of a monostotic and polyostotic process is always an embarrassing one. We never know when to say a monostotic osteitis fibrosa is going to become a generalized type, and I think that we are going to have this same question regarding the giant cell tumor. There doesn't seem to be very much opposition to admitting the multiple giant cell tumors into the parathyroid group, but there is quite a prejudice against admitting the single giant cell tumors. We have had one recent experience which was very instructive, although we do not yet know how it is going to come out.

In 1925 Dr. Ballin did a biopsy on a single giant cell tumor in a man at about the age of thirty. We have the section. It is an ordinary, garden variety of giant cell tumor. In 1928 the tumor recurred, and we did another biopsy. It is still the ordinary, garden variety of giant cell tumor. There are no other lesions in the body. This year the tumor recurred again. It is a beautiful example of Dr. Dresser's statement that they often become malignant after repeated traumatization, because this time it presents the picture of a polymorphous cell sarcoma of very malignant type and we have grave doubts as to its prognosis. That man was parathyroidectomized, and he had about the most pathological parathyroid adenoma I have seen in months. I cannot tell you how that case is coming out. He may die of malignant sarcoma, but I can't get away from a feeling that the association of that monostatic giant cell tumor, recurring twice, and finally becoming malignant, with a very pathological parathyroid gland was not a coincidence.



ANKYLOSING SPONDYLITIS AND POLYARTHRITIS*

(BECHTEREW, STRÜMPELL-MARIE, AND RELATED TYPES)

By E. WALTER HALL, M.D.

DETROIT, MICHIGAN

IN THE earlier part of the past century cases of ankylosing spondylarthritis were classified as arthritis deformans, a term suggested by Virchow. In 1893 von Bechterew, from observation of 500 cases of spinal rigidity, found some which seemed to him to present distinct characteristics and to be worthy of classification as a separate disease. He recognized a type of spinal arthritis in which there was progressive stiffening of the vertebral column beginning in the thoracic region and extending downward, associated with marked thoracic kyphosis. This was accompanied by signs and symptoms of nerve involvement, namely, paralysis and atrophy of the muscles of the back, especially the upper portions, diminished sensitivity of cutaneous nerves, changes in reflexes, and psychic phenomena. Other joints of the body were thought by Bechterew to be uninvolved.

Bechterew's spondylitis is so well known to roentgenologists that only a brief description is necessary. In advanced cases there are shown roentgenologically a well-rounded dorsal kyphosis with anterior narrowing of the vertebral bodies which are fused at their anterior margins, marked atrophy of the intervertebral discs with much deposit of calcium in the cartilages, and ossification of the paraspinal ligaments. Due to the muscular atrophy which is present and believed by some to be primary to the changes in the vertebrae, Knaggs has called this type "spondylitis muscularis." Bechterew regarded trauma as the exciting cause of the disease with an underlying hereditary predisposition as the main etiologic factor. He considered trauma as ineffective in producing the disease without the presence of such a hereditary tendency. Marie recognizes these etiologic fac-

tors in his term for the condition, "cyphose hérédo-traumatique."

Strümpell in 1897 and Marie in 1898 described a somewhat different form of ankylosing spondylitis in which the disease is first manifested in the lower spine and progresses dorsalward. In this type of malady there is usually prostration, the patient being confined to bed, and generally in severe pain. Stiffness progresses rapidly and pathologic changes, though starting in the lower back, soon involve all the portions of the spine rather uniformly.

Strümpell-Marie's spine is also well known to all roentgenologists so it is necessary to review only the main roentgen findings. In marked cases, we find the sacroiliac joints entirely obliterated by a firm, bony ankylosis. The vertebrae show no change in form, although there is generalized demineralization. The intervertebral discs are of normal width but take on an osseous character and the paraspinal ligaments are ossified, forming a thin bony sheath for the entire column. The usual involvement of the hips and shoulders in the ankylosing process led Marie to designate the affection as "spondylose rhizomelique." Marie believed the disease he described to be limited to the joints of the spine and the roots of the limbs, the other joints of the body being uninvolved in the process. Knaggs classifies the Strümpell-Marie type of spondylitis as "spondylitis ossificans ligamentosa," considering the ligamentous ossification to be the most important change in the involved tissues. Marie considered this form of ankylosing spondylitis not directly infectious but probably of toxic origin and indicated the possibility of a nutritional basis for the disease. He admitted that Neisserian infection gave a picture at times

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

indistinguishable except for the history.

Many writers question the validity of separating the Bechterew and Strümpell-Marie types of spondylitis from other forms of generalized arthritis which may or may not affect the spine. Tubby believes that arthritis deformans accounts for the greater portion of rigid spines and probably all of those of the Bechterew type. Heinemann-Grüder presents a number of cases showing characteristics of both chief types of ankylosing spondylitis as well as of arthritis of the smaller joints of the extremities and believes they are not distinguishable symptomatically, pathologically, or from the standpoint of etiology. Oppel believes that spinal manifestations are mere incidents and that in a given disease manifested by arthritic changes the same physical and chemical factors are operative in the selection of the spine as the site of the involvement as of other parts of the body. Of these factors trauma, occupational posture, strain, or pre-existing local infection may play a part. Steindler holds the view that to regard spondylarthritis as a systemic disease with spinal manifestations merely as the cardinal symptoms gives the best approach to relief of symptoms and arrest of the process. It is this point of view that we wish to emphasize and which we believe may give new impetus to the treatment of ankylosing spondylarthritis after several decades of relatively little progress.

As stated above, the chief etiologic factors in the so-called Bechterew or hypertrophic type of spondylarthritis are supposed to be hereditary predisposition and trauma, and in the so-called Marie or atrophic type some toxic condition associated with chronic infection, with the possible added influence of trauma. To quote Heinemann-Grüder, "Neither trauma nor infection but a latent readiness of the body to answer to irritation of many kinds by producing spinal ankylosis is the fundamental consideration in this problem."

The question is naturally suggested as to whether the type of cases under discussion can be logically considered to be of meta-

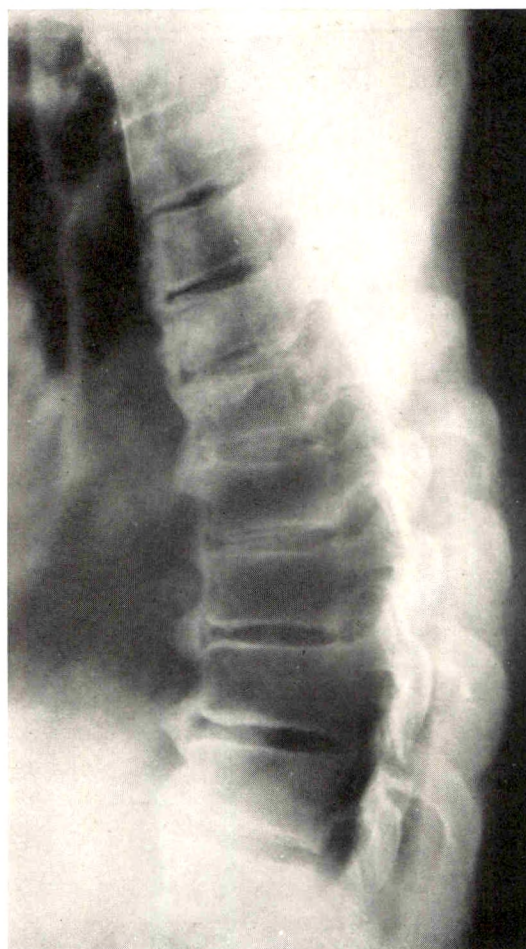


FIG. 1. Bechterew's spondylitis. Calcium deposits in the ligaments and in the intervertebral discs in the mid-thoracic region. Slight wedging of the vertebral bodies which are demineralized except the margins adjacent to the cartilages.

bolic or endocrine origin, and so related to parathyroid function that a therapeutic approach can be made from this angle. It is quite evident from a study either of roentgenograms or of necropsy specimens that in ankylosing spondylitis we are dealing with a condition of calcium metastasis. Much calcium is absent from its normal place in the bones and is present in large amounts in the soft tissues surrounding them. That it is distributed in different locations and degree seems not to be vital to the question, but rather significant of the presence and influence of various mechanical factors.



FIG. 2. Bechterew type. Calcium metastasis to the ligaments, the discs being preserved and the vertebral bodies not deformed. Such a case responds favorably to alterations in calcium and phosphorus metabolism through the parathyroids.

In the slowly progressive Bechterew type of spondylopathy the factors are operative over long periods of time. Due to the fact that the patient is not incapacitated, stress, strain and mobility are continually active and influence the architecture as well as the chemical composition of the bones. The hypotonicity of the muscles of the back, which is one of the known manifestations of hyperactivity of the parathyroid glands, allows the spine to be bowed forward and at the same time lessens the mobility. Pressure is brought to bear on the intervertebral discs anteriorly, producing atrophy of cartilage to the extent that

the bodies eventually contact and fuse with osteophyte formation. Whether it is a protective measure or not it is difficult to say, but for some cause, calcium salts are removed from the vertebrae and deposited in adjacent spinal ligaments, causing further ankylosis. This is, no doubt, partially due to lessened ligamentous function. Eventually the functionless cartilages also become the depository for mineral salts. Ossification of the less expansile discs advances from the periphery to the center, as



FIG. 3. Strümpell-Marie type of spondylitis. Calcified ligaments, normal size of intervertebral discs and normal body contour.

would be expected both from the greater insult to the periphery anteriorly and from the greater lability of the nucleus pulposus. The vertebral bodies seem to show greater lime content anteriorly where there is osteophyte formation, but careful observation shows them considerably decreased in density elsewhere so that their total mineral salt content is definitely lessened. In this condition, therefore, we find two probable effects of parathyroidism: the first in producing hypotonicity of the musculature, and the second in regulating calcium metastasis. In this connection it may be stated that most authors consider the *dorsum rotundum* of adolescence and that of senility to belong in the same group as the Bechterew type of spondylitis.

The Strümpell-Marie type, as Knaggs' term "spondylitis ossificans ligamentosa" indicates, has for its chief feature marked transposition of mineral salts from the vertebral bodies to the adjacent ligaments. This occurs so rapidly that mobility of the spine is greatly reduced early in the disease, consequently no deformity of the bodies occurs, neither is there pressure atrophy of the intervertebral cartilages and the disc spacing remains normal throughout. The anterior longitudinal ligament is first to ossify, this occurring very early in the illness. Later the posterior common ligament, and ligamenta flava, the capsular ligaments of the articular processes, and finally the costovertebral ligaments become firmly ossified. At this stage the intervertebral discs, no longer functional, undergo calcification and ossification, the process progressing from periphery to center.

Here, then, is a most spectacular disturbance in calcium distribution. Most authorities have assumed that the calcium metastasis is purely a defense reaction, that it is Nature's method of immobilization of painful joints in preserving them from destruction. This explanation seems inadequate in view of the relatively small effort Nature makes to immobilize the joints in many other localized destructive and painful arthritides. A more plausible view is



FIG. 4. Spondylitis, chiefly atrophic. This patient showed a general polyarthritides of ankylosing type following scarlet fever. The absence of definite calcium metastasis would render this type somewhat unfavorable to therapeutic alteration of parathyroid function.

that the calcium metabolism is not under normal control, or is unduly stimulated so that if Nature is trying to protect the diseased areas she carries the process entirely too far. If, as seems proved in many cases, infection plays a major part in the etiology of spondylitis, it seems quite prob-

able that the toxins from the same infectious process act as parathyroid stimulants so that parathyroidism becomes the most important, if not the primary, factor in producing the para-articular changes. It is also an interesting speculation as to whether there may not be a hereditary or familial tendency to parathyroid dysfunction to explain the quite generally accepted hereditary factor in spinal ankylosis of the Bechterew type. This is a problem worthy of careful study.

- Oppel and his associates have conducted investigations into the metabolism of patients suffering from spinal as well as generalized ankylosing arthritis. He reports that Belsgorodsky found all patients of his series with ankylosing polyarthritis to have increased blood calcium, while Samarin found serum calcium increased in only 28 of a series of 42 such cases, the remaining 14 being normal.

Barr believes that calcium metastasis is dependent not on hypercalcemia but rather on hyperphosphatemia, there being extensive deposit of calcium salts in soft tissues when the serum phosphate is elevated with only slight increase in serum calcium. Conversely, cases with marked hypercalcemia and low serum phosphate may show extensive demineralization of bone with no demonstrable deposit of calcium in the soft tissues. Nekroff found the inorganic phosphorus increased to 3.43 mg. per 100 c.c. (the normal being 2.8 mg.), while the organic phosphorus was normal. Demidovskaya found the viscosity of the blood increased from 20 to 40 per cent. Samarin found lymphocytes increased to 50 per cent of the total white count in the blood of 75 per cent of the series. Simon, Levy, Weissenbach, Le Riche and others, report blood calcium determinations quite variable, the calcium being often not only unincreased but even decreased.

However varied the laboratory findings, the patients have benefited by changing the calcium metabolism. Some have responded to surgery while others with almost identical symptoms have improved follow-

ing injections of parathormone. Simon believes hypofunction of the thyroid may play an important part in the production of ankylosing arthritis while some investigators give more credit to the pituitary gland. The whole question is yet in a state of uncertainty and shares in the complexity of endocrine problems in general.

Oppel's laboratory and clinical findings are sufficiently indicative of parathyroid dysfunction to have induced him to remove the parathyroid in many cases of ankylosing polyarthritis. His results have been highly encouraging. Of a series of 30 cases 27 showed 1 to 3 mg. reduction in serum calcium after parathyroidectomy. The symptomatic results were even more striking, the sensation of stiffness and pain being entirely relieved in one patient after twenty-six hours and in others almost as soon. Joints in which motion was almost impossible became freely movable. Patients with stiffened spinal columns increased in stature several centimeters due to their ability to assume a more erect position.

Other surgeons have had results similar to those of Oppel. Ballin and Morse have reported several cases seemingly belonging to the Bechterew type of spondylitis in which parathyroidectomy produced marked relief of pain and stiffness. Simon has reported a number of cases of ankylosing polyarthritis with favorable results from operations in the region of the parathyroids with or without removal of parathyroid tissue and with no demonstrable microscopic change in tissues which were removed. Whether or not the parathyroid, the thyroid, or the pituitary theory is accepted as the correct explanation for the conditions under discussion, the remarkable clinical effects of surgical procedure in the region of the lower pole of the thyroid are indisputable. Of course one cannot hope to restore articulations to normal where there is complete ankylosis with formation of solid bone, but symptoms are definitely relieved and in early or moderately advanced cases there is every reason to expect the arrest of the ankylosing process by

parathyroidectomy. Oppel's successes have led him to advocate removal of parathyroids previous to every arthroplasty for cure of ankylosis, logically assuming that recurrence of ankylosis is less likely when calcium metastasis is prevented.

It should be borne in mind that while no assertion is made that parathyroidism is the chief or primary cause of the usual forms of polyarthritis, the generally accepted theories of infection and toxic conditions being the most plausible explanation on clinical grounds, parathyroidism is probably responsible for the ankylosing feature seen in so many cases. The theory that endocrine imbalance with resultant calcium metastasis is the main etiologic factor in certain types of ankylosing spondylarthritis of obscure etiology is quite ten-

able and worthy of use as a working basis for clinical purposes.

It is to be hoped that results of reported cases will stimulate those in charge of patients with ankylosing arthritis, and especially the early cases with muscular hypotonia, stiffness, and pain preceding the stage of joint ankylosis, to investigate them very thoroughly with the idea of parathyroidism in mind. We believe that in many instances parathyroidectomy would benefit the chronic arthritic showing tendencies toward ankylosis more than many of the routine measures now employed in their treatment. We would not minimize the importance of removal of foci of infection and general therapeutic procedures, but rather emphasize this new instrument which may be effectually used to prevent ankylosis.

REFERENCES

1. BALLIN, M., and MORSE, P. F. Parathyroidism. *Am. J. Surg.*, 1931, 12, 403-416.
2. BALLIN, M., and MORSE, P. F. Parathyroidism and parathyroidectomy. *Ann. Surg.*, 1931, 94, 592-609.
3. BARR, D. P. Pathological calcification. *Physiol. Rev.*, 1932, 12, 593-624.
4. VON BECHTEREW, W. Stiefigkeit der Wirbelsäule und ihre Verkrümmung als besondere Erkronkungsform. *Neurolog. Centralbl.*, 1893, 13, 425-434.
5. GEIST, EMIL S. The intervertebral disk. *J. Am. M. Ass.*, 1931, 96, 1676-1679.
6. HEINEMANN-GRÜDER. Betrachtungen zur Frage der ankylosierenden Spondylitis. *Arch. f. klin. Chir.*, 1927, 145, 527-560.
7. HUNTER, D., and TURNBULL, H. M. Hyperparathyroidism. *Brit. J. Surg.*, 1931, 19, 203-284.
8. KNAGGS, R. L. Spondylitis deformans. *Brit. J. Surg.*, 1925, 12, 524-546.
9. LEVY, M. Un cas de rhumatisme chronique déformant traité avec succès par la parathormone. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1931, 55, 1847-1849.
10. MARIE, PIERRE. Sur la spondylose rhizomelique. *Rev. de méd.*, 1898, 18, 285-345.
11. OPPEL, V. A. Parathyroidectomy for ankylosing polyarthritis. *Ann. Surg.*, 1929, 90, 978-981.
12. RICHARDSON, E. P., AUB., J. C., and BAUER, W. Parathyroidectomy in osteomalacia. *Ann. Surg.*, 1929, 90, 730-741.
13. SCHMORL, C. G. Pathologic anatomy of the intervertebral disc. *Beitr. z. klin. Chir.*, 1931, 151, 360-375.
14. SIMON, R. Des opérations thyroïdennes et parathyroïdennes dans le rhumatisme chronique déformant. *Rev. franç. d'endocrinol.*, 1932, 10, 36-60.
15. SIMON, R., and WEILL, J. Operations sur la région des parathyroïdes et rhumatisme déformant. *Presse méd.*, 1932, 40, 412-414.
16. SNAPPER, I. Maladies osseuses et parathyroïdes. *Ann. de méd.*, 1931, 29, 201-221.
17. STEINDLER, ARTHUR. Diseases and Deformities of the Spine and Thorax. C. V. Mosby Co., St. Louis, 1929, pp. 498-525.
18. TUBBY, A. H. Deformities, Including Diseases of the Bones and Joints. 1923, Vol. II, 425.
19. WEISSENBAACH, R. J., FRANÇON, F., PERLÈS, L., and SEIDMANN, P. Traitement de certaines formes graves du rhumatisme chronique déformant progressif par les extraits parathyroïdiens. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1930, 54, 1843-1854.

DISCUSSION

DR. P. F. MORSE, Detroit, Mich. Dr. Evans has suggested that it might be well to get a little better fixed in your minds this question of ankylosing spondylitis and polyarthritis. Dr. Hall went over the details and emphasized the proper points, but we still often find that the medical profession misinterprets Oppel's point of view. In the first place, Oppel does not claim that the parathyroid has anything to do with the rheumatism. He does not claim that it has anything to do with the spondylitis, whether it be of the Strümpell-Marie or Bechterew type.

All that Oppel claims is well illustrated by one of his experiments in which he took a normal dog and put a ligature above and below the joint to produce chronic hyperemia in a normal dog and then administered parathormone over a long period of time. They were able to ankylose that normal joint.

Oppel did claim that when any polyarticular rheumatism on an infectious or other basis is accompanied by a coincident parathyroidism and hypercalcemia, progressive ankylosis and joint pain result. Those of you who have read Oppel's papers will appreciate the remarkable results he has obtained. Besides this phase we should keep in mind the purely rheumatic symptoms of parathyroidism itself.

Some of the clinical details of Dr. Ballin's cases are very striking. I wish he would say a few words about one of his recent cases which has not yet been operated upon.

DR. MAX BALLIN, Detroit, Mich. Oppel reports his cases very carefully and claims only about 50 per cent good results from parathyroidectomy in "ankylosing polyarthritis." We have done 15 such operations for the arthritic type; we had good or fair results in only about 10 cases. That, perhaps, indicates the most important point, that one should pick out such cases very carefully. Our orthopedic friends and, in fact, every physician and patient with arthritis, are apt to try almost anything in this stubborn affection, but we must be very careful not to spoil this chapter of parathyroidism by indiscriminately applying parathyroidectomy for arthritis.

Generally arthritis has nothing to do with

parathyroidism, but at times parathyroidism goes under outstanding symptoms of arthritis and then we have to substantiate the diagnosis by bringing out other parathyroid symptoms. I do not believe that the difference in types of arthritis, be it the Strümpell-Marie or Bechterew type, should be the distinctive feature. To call an arthritis parathyroidal we should have, besides arthritis, hypotonia of the muscles, some changes in the blood chemistry and phosphorus chemistry, even if not very pronounced, also a roentgenogram showing decalcification, areas of osteitis fibrosa cystica and secondary calcium deposits.

Oppel and his pupils have made experiments by injecting dyes into the blood stream and these were deposited around inflamed joints exactly in the spots where the metastatic calcium deposit takes place and where there was inflammation previously. He further states that an infectious arthritis generally heals without ankylosis. The latter occurs in only 5 to 10 per cent; and then hypercalcemia and secondary calcium deposits enter the picture to produce ankylosis. Ergo, more symptoms of parathyroidism are needed to include an arthritic process in this group.

Osteopoikilosis can perhaps be understood also as such metastatic calcium processes. I think Dr. Wilcox said osteopoikilosis had been reported about 15 times. Since then at Harper Hospital several such cases and in our own service 5 or 6 cases have been seen. It is therefore not so infrequent, but as it usually produces no symptoms it is not looked for generally. However, more and more, here and there we are seeing it in combination with parathyroid osseous changes and one French case has been reported where an actual parathyroid tumor was found.

And here is a film of a real parathyroid tumor case of ours with giant cell sarcoma, etc. You can see the calcium coming back in spots after parathyroidectomy. We have seen that now in 3 cases. In other words, in parathyroidism the calcium comes back intensively in spots resembling osteopoikilosis; but I do not say at this time there is any etiological relationship between parathyroidism and osteopoikilosis.

OSTEOPOIKILOSIS*

By LESLIE F. WILCOX, M.D.
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 DETROIT, MICHIGAN

OSTEOPOIKILOSIS is characterized by a disseminated condensation of the bones of the skeleton without clinical symptoms. All of the bones have been shown to be involved except the bones of the skull. The multiple areas of increased density vary in size from foci 2 millimeters in diameter to those having a width of several millimeters and a length of several centimeters. Thus they may be grossly spherical, oval or oblong in form. Curiously enough, they are always found in the spongiosa of the epiphysis and the metaphysis of the bones. They are not found in the mid-portion of the diaphysis of the long bones. These foci of condensation in the cancellous bone are arranged so their long axis is parallel to the long axis of the shaft, except in such parts as the neck of the femur where they do not lie strictly axially but follow the shaft structure of the column very distinctly.

The condition has been observed in both males and females and as it occurs without symptoms, it is found by accident during a roentgen examination for some other condition. The blood calcium and phosphorus determinations have been normal in those cases in which it was studied.

Albers-Schönberg¹ first reported a case in 1915 calling it a rare structural anomaly of the skeleton. Ledoux-Lebard, Chabaneix and Dessane² reported a case the next year and because of the spotted appearance of the bones they gave it the name "osteopoeilia." In 1929 Newcomet³ of Philadelphia reported the first case in the English literature. His case had been observed over a period of four years and during that time there had been no change in the character of the bone involvement.

Three types of this condition have been described by several authors. These are,

the spotted form which is the one most commonly seen, the striated form which is relatively rare and in which there are long narrow striations of dense bone and the mixed form which is a combination of the two.

In a search of the literature we have been able to find 23 cases of osteopoikilosis which include 2 cases recently reported by me²² and of which a brief résumé is given here.

CASE I. H. C., white male, aged twenty-one, bookkeeper, was admitted to the Surgical Service of Harper Hospital, October 22, 1931, with a history of lower abdominal pain. During a previous roentgen examination elsewhere of the urinary tract, an unusual condition of the bones of the pelvis was observed and he was sent to the roentgen department for further study. The past history of this patient was entirely negative.

Laboratory examination in the Hospital revealed nothing of importance. There was no anemia or leucocytosis and the urinary findings were negative. The blood calcium was 10.5 mg. and the inorganic phosphates 2.5 mg.

Roentgen Report. Examination of the patient's skull, dorsal and lumbar spine, pelvis and the extremities, including the hands and feet, reveal a rather unusual distribution of calcium deposit or increased bone density in the ends of the bones, especially in the humeral heads, the glenoid process of the scapulae, head, neck and intertrochanteric regions of the femora, in the ilia, both ischial and pubic bones, sacrum and spinous processes of the lumbar vertebrae, the lower ends of the tibiae, the bones of the feet, the lower ends of the radii and the ulnae, all of the bones of the wrists and most of the phalanges, to a greater or less extent. The bones of the skull, the ribs and the mid-portions of the shafts of the long bones were alone uninvolved.

CASE II. M. C., white male, aged fifty-two, the father of Case I, was examined. The past history in this case was also essentially negative.

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

Roentgen Report. Examination was made of the pelvis, both hands, right knee and right foot. Multiple small areas of increased density were present in the bones of the wrists and hands, the ilia, sacrum, ischii and pubic bones, the femur, tibia, fibula and all the bones of the foot.

A brother of Case 1, C. C., aged twenty-five, was examined and a normal structure of the bones of both wrists and hands, the pelvis, the right knee and the right foot were found.

A sister of Case 1, V. C., aged twenty-eight, was also examined and here again there was no evidence of the spotted structure in the long bones.

The illustrations of these cases may be seen by reference to the earlier article.²²

The etiology is unknown but it is evident that there are more or less uniform disturbances in the proliferation and ossification of bone-forming cartilage during the period of development. Voorhoeve,²⁰ who reported 2 cases in 1924 and made an extensive study of this condition, stated that he believed the anomaly to be hereditary and that it should be placed in the group of dyschondroplasias.

To Schmorl¹⁷ we are indebted for the greatest amount of information on this condition. He had the opportunity to make a post-mortem study, both grossly and microscopically. In 1931 he reported a case of osteopoikilosis in a boy eighteen years of age who had suffered from multiple osteomyelitis and had died from severe secondary anemia and amyloidosis. Autopsy study was made and the report by Schmorl is summarized as follows:

Serial microscopic examination of the spotted areas revealed that the increased density was the result of numerous bone trabeculae of various thicknesses arranged rather regularly, the bone resembling the structure of the spongiosa and not the cortex. The individual trabeculae were slightly thicker than those of the normal bone in that particular region. Because of this and their close arrangement, they gave the impression of a compact bone. The merging into the surrounding structures was gradual, the trabeculae disappearing among those of the normal spongiosa. The thicker trabeculae consisted of lamellous bone arranged mostly paral-

lel, but in a few instances also concentrically around blood vessels, however without leading to the picture of typical osteoma.

No deductions can be made from the above microscopic findings concerning the genesis of the disease. An endochondral origin can be eliminated on the basis that the foci show no connection with the endochondral zone of growth. The most plausible theory is that of a congenital anlage.

We became interested in the hereditary nature of the etiology of osteopoikilosis. Awalschwili³ reported that 6 brothers of his patient were examined and the condition had not been found. Mascherpa⁹ reported that the brother and sister of his case had been examined and each showed slight signs of the disease. In our cases the disease was present in father and son and the disturbances observed were so uniform that the hereditary character of the lesion at once became apparent.

From the study of this condition we are led to conclude that it is a hereditary anomaly developing from a congenital cartilage anlage. We do not believe it can be truly classed as a malacic bone disturbance. To support this view we cite the following observations:

1. The bone structural changes, while having a generalized skeletal distribution, are limited to certain specific areas in the bones, namely the cancellous or spongy bone of the epiphyses and the metaphyses, that part of the bone which is developed by endochondral ossification.

2. The roentgen picture of the bones is not that of generalized lessening of the calcium content or halisteresis.

3. The blood salts of calcium and phosphorus which comprise the major portion of the bone salts are unchanged in quantity in osteopoikilosis.

4. The cases observed have not suffered any symptoms which could be definitely ascribed to the presence of the unusual foci of condensation of the bones.

5. Our cases showed a marked similarity of the disturbances in the skeletal system in the father and son, which we believe is evidence of a hereditary etiology.

BIBLIOGRAPHY

1. ALBERS-SCHÖNBERG. Eine seltene, bisher nicht bekannte Strukturanomalie des Skelettes. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1915-1916, 23, 174-175.
2. AMUNDSEN, P. A case of disseminated condensing osteitis. *Acta radiol.*, 1930, 11, 120.
3. AWALISCHWILI, G. Zur Kasuistik der Osteopoikilie. *Röntgenpraxis*, 1930, 2, 831-833.
4. BISTOLFI. Su di un caso di osteopocilia (osteite condensante disseminata). *Radiol. med.*, 1927, 14, 1024.
5. GLUCH, B. Ueber einen Fall von Osteopoikilie. *Röntgenpraxis*, 1929, 1, 505-507.
6. KAHLSTORF, A. Zur Kenntnis der Melorheostose (Léri) und der generalisierten Ostitis condensans oder Osteopoikilie (Albers-Schönberg). *Röntgenpraxis*, 1930, 2, 721-732.
7. KÖNIG, E. Osteopoikilie. *Chirurg.*, 1930, 2, 875-878. Abst. in *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1930, 42, 406-407.
8. LEDOUX-LEBARD, R., CHABANEIX, and DESSANE. L'ostéopocilie; forme nouvelle d'ostéite condensante généralisée sans symptômes cliniques. *J. de radiol. et d'électrol.*, 1916-1917, 2, 133-134.
9. MASCHERPA, F. Sulla osteopocilia. Un nuovo caso di osteopocilia a stria. *Radiol. med.*, 1931, 18, 1014-1027.
10. MOREAU, L. Sur un nouveau cas d'ostéite condensante généralisée (ostéopocilie). *J. de radiol. et d'électrol.*, 1918-1919, 3, 318-319.
11. NEWCOMET, W. S. "Spotted bones." *AM. J. ROENTGENOL. & RAD. THERAPY*, 1929, 22, 460-463.
12. PIERGROSSI, L. L'origine delle striae trasversali paraepifisarie da crescita. *Rinasc. med.*, 1927, 4, 452-454.
13. PIERGROSSI, L. Osteopocilia ed osteosclerosi. *Rinasc. med.*, 1931, 8, 513-516.
14. REISER, E. Osteopoikilie. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1931, 43, 808.
15. RICHARZ. Multiple Kompaktaherde in der Knochenspongiosa. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1921-1922, 28, 86-87.
16. SCHÉLE, A. A case of a rare skeleton anomaly. *Acta radiol.*, 1921-1922, 1, 536-539.
17. SCHMORL, G. Anatomische Befunde bei einem Falle von Osteopoikilie. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1931, 44, 1-8.
18. STEENHUIS, D. About a special case of ostitis condensans disseminata. *Acta radiol.*, 1926, 5, 373-374.
19. VAN PÉE, P. L'Ostéopocilie et les ostéites condensantes. *Liège méd.*, 1931, 24, 937-946.
20. VOORHOEVE, N. L'image radiologique non encore décrite d'une anomalie du squelette. Ses rapports avec la dyschondroplasie et l'osteopathia condensans disseminata. *Acta radiol.*, 1924, 3, 407-427.
21. WATCHEL, H. Ueber einen Fall von Osteopathia condensans disseminata. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1919-1921, 27, 624-625.
22. WILCOX, L. F. Osteopoikilosis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 27, 580-584.

DISCUSSION

DR. R. S. BROMER, Bryn Mawr, Pa. If osteopoikilosis which is a condensing osteitis of bone is included in this category, then why are not other condensing osteites of bone, such as the sclerosing osteitis of Garré, the melorheostosis of Léri and others also included? I would like to ask this question of Dr. Morse.

DR. P. F. MORSE, Detroit, Mich. In answer to an objection raised by Dr. Bromer to including osteopoikilosis in the category of "malacic bone disease," I might explain how both osteopoikilosis and marble bone disease got into this program. Dr. Evans and I discussed that point at the time the program was being made up. It was merely because some cases of osteopoikilosis came along and came to our attention, and

were considered at the same time that the parathyroid subject was being actively considered, and the same thing was true of marble bone disease. Certainly osteopoikilosis and marble bone disease are not in general bone malacias in any true sense as the rest of this group are. I think Dr. Bromer is right in objecting to putting osteopoikilosis in any formal discussion of malacic diseases of the bone. I do not think it belongs there. Personally I have not seen anything that makes me think it is at all related to the parathyroid, but that does not make any difference because many of the malacic diseases of the bone are not related to the parathyroids. However, I think his remarks are pertinent and entirely correct.



MARBLE BONES*

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MARBLE bone disease was first described by Albers-Schönberg in 1904. For ten years no other case was described. In 1914 von Schick described a case, and

at isolated intervals other cases were described in the literature. At a meeting of this Society in 1923 Dr. William G. Alexander¹ reported a case. In 1929 I² collected 26 reported cases and reported 5 new ones, and in 1930 Kudrjawtzewa³ reported 26 cases from the literature. In a study of 2,500 children Karshner established 4 cases. It is evident, therefore, that marble bones is a rare condition.

Roentgen examination is necessary to establish the diagnosis, though a definite train of clinical symptoms has been established.

The changes in a fully developed case consist in the transformation of the spongy parts of the bones into solid compact tissue. The roentgenogram shows the bone white and structureless. The bones are brittle and break easily. The base of the skull is thickened, and the depth of the sella turcica is lessened. Where the spongy part of a bone is not sclerosed it exhibits osteoporosis with a wide meshwork of the trabeculae.

There is usually a blood change due to absence of the medulla of the bones. There may be anemia and enlargement of spleen, liver and lymph glands.

Cases have been reported from the age of three to forty-eight. The parents of children with marble bones may be free of the disease. A case is reported of a father and mother who were closely related, the man being uncle two degrees removed from the woman. They had children with marble bones. Each of these parents had been previously married, and each had had healthy children, yet when they united the mother

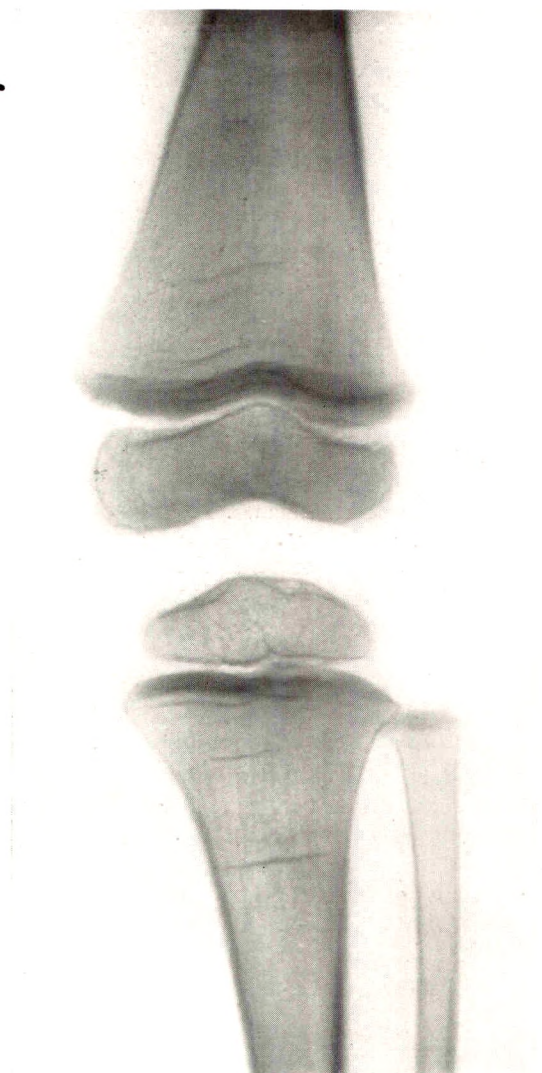


FIG. 1. Female, aged two and a half. This shows the dense line of lead poisoning which is indistinguishable from marble bones in an early stage. (Courtesy of Dr. Childe, Children's Memorial Hospital.)

¹ Alexander, W. G. Quoted by Pirie.

² Pirie, A. H. The development of marble bones. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1930, 24, 147-153.

³ Kudrjawtzewa, N. Ueber Marmorknochenkrankheit. *Arch. f. klin. Chir.*, 1930, 159, 658-687.

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit Mich., Sept. 27-30, 1932.

bore children who developed marble bones. Consanguinity plays an important part in the appearance of the disease.

The bones change little in their shape, but there is a distinct tendency for the bones at the shoulder and knee to become club shaped, and for the surface of the bone there to grow fluted like a Corinthian pillar.

The disease is usually first recognized because of a fracture, which is the transverse type seen in a pathological fracture.

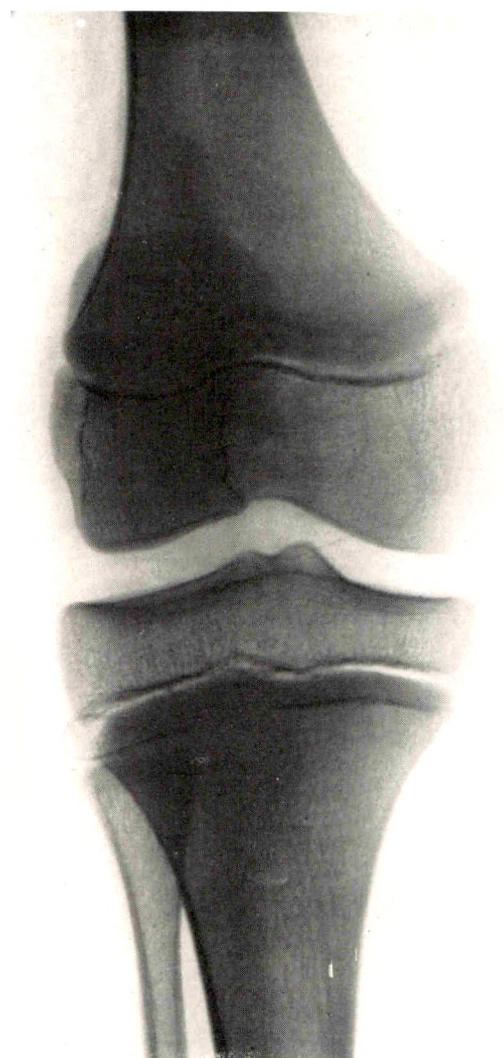


FIG. 2. Male, aged ten and a half. This shows the dense line produced by treatment for nine months with bismuth as antiluetic treatment. (Courtesy of Dr. Childe.)

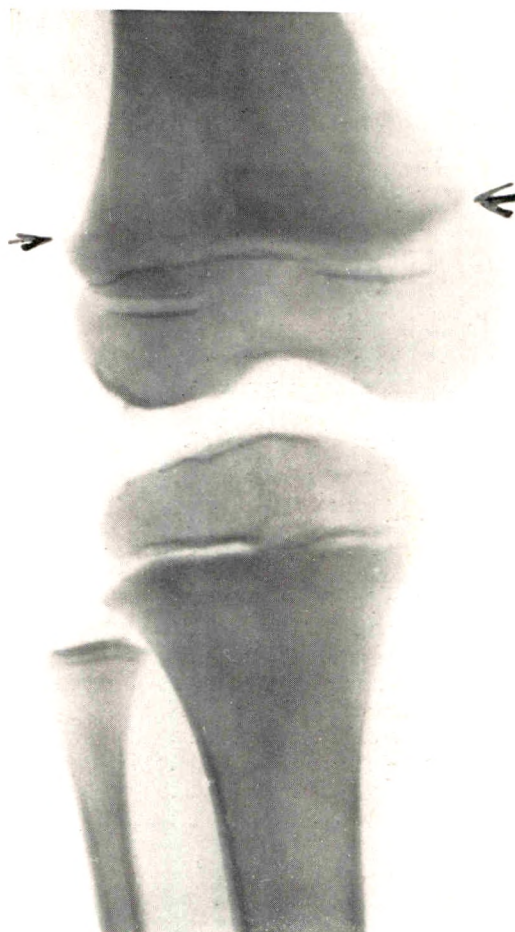


FIG. 3. Marble bones at an early stage. Note the beginning of the marble-like appearance in the same place as in lead and bismuth poisoning.

It heals readily and callus forms freely. It is not so easy to recognize the early stages of the disease.

No case of intrauterine marble bones has been described. At a meeting of this Society about nine years ago I showed a slide of a fetus in a mother who had well developed marble bones, but this child six years later showed only slight evidence of marble bones. The condition seems to develop at an age when thickening appears in the metaphyses from other causes. For instance in young children with rickets and scurvy a thickening appears at the metaphyses when curative treatment is going on. The same is seen when excess of phosphorus is

fed to a growing infant. We see it also in lead poisoning, bismuth poisoning and strontium poisoning.

Some illustrations are included of lead

must be withdrawn or the patient dies, but in the case of marble bones the patient does not die even though the cause is not withdrawn, and the sclerosis goes on till the whole bone is sclerosed.

The appearance of the short bones is also characteristic in the advancing stage as they are circled by dense bone (Fig. 4). This is seen in the tarsal and carpal bones, in the vertebrae and in the iliac bones. One should be familiar with these appearances in order to look for typical marble bones elsewhere. When marble bones is suspected one should examine the ends of the bones which grow most rapidly, for it is there that the disease shows itself best, namely, at the upper end of the humerus, at the ends of the tibia and femur, and at the knee joint.

Changes in the blood are frequent but inconstant in degree. The enlargement of the spleen, liver and lymph glands may be a compensating factor to supply the loss of the blood-forming function lost by the medullary cavity which becomes sclerosed.

Osteoporosis is recognizable in the roentgenogram and microscopically as an antecedent to the osteosclerosis of marble bones.

Chemical analysis of the bone shows little change. The calcium content is raised about 1 per cent and the phosphorus rather less, though the phosphorus content of the blood has been found raised in many cases. This may be an important influence in the production of marble bones, as experimentally a condition of marble bones has been produced in animals by overfeeding with phosphorus.

Fractures which are common in marble bones are characteristic. They may be painless. They are transverse and not splintered, in fact, they break as if the bone had been changed into chalk rather than into marble, and the dense bone can be worked upon with a drill as if it were chalk.

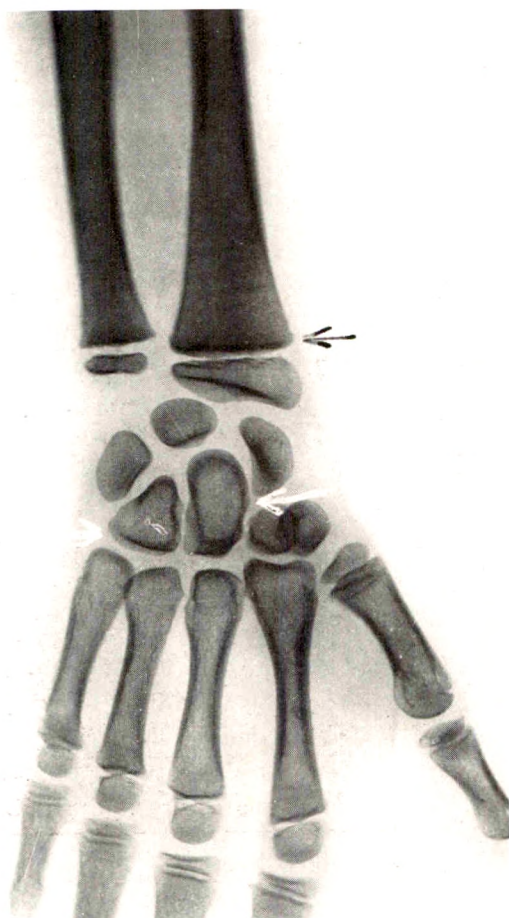


FIG. 4. Early stage of marble bone disease showing the circling of the carpal bones by a ring of dense bone.

poisoning (Fig. 1), and bismuth poisoning (Fig 2) supplied to me by Dr. Childe of the Children's Memorial Hospital of Montreal so that these may be compared with the early cases of marble bones (Figs. 3 and 4).

In the cases of poisoning by lead, phosphorus, strontium and bismuth, the cause



KASHIN-BECK'S DISEASE*

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KASHIN-BECK'S disease fortunately does not occur in North America, and we are therefore unfamiliar with it. In order to complete this symposium on Malacic Diseases of Bone it has been added, and a short description of the disease is here presented, taken mainly from the works of Kashin and Beck and as described by Schipatschoff¹ of Irkutsk, Siberia.

A general idea of the disease may be obtained from photographs of persons suffering from it. Figure 1 shows a boy with hands very deformed by the disease, illustrating the bear's paw deformity of the hands. The bones are shortened and the joints are swollen. Figure 2 shows two patients with the disease fully developed. Note the deformities caused by shortening of the bones, changes in the joints and atrophy of muscles. Figure 3 shows two similar patients. Figure 4 shows the roentgen appearance of the head of the femur, with a normal femur for comparison. The appearance is similar to an advanced case of osteoarthritis. The gross specimens of the humerus (Fig. 4) show the shortening and deformities at the ends of the bones. A normal humerus is shown for comparison.

The endemic area is Siberia to the north of Manchuria, between the River Schilka to the north and the Argon to the south where nearly a million people exist.

Kashin described a disease in 1850 in the Transbaikial region of Siberia. He described it as a form of arthritis, and could only obtain cures by making the inhabitants of the affected area leave their homes and move to another part of the country.

¹ Schipatschoff, W. G. D'e Kaschin-Becksche Krankheit (Osteoarthritis endemica.) *Deutsches Arch. f. klin. Med.*, 1931, 173, 133-145.

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

As to the cause of the disease, Kashin said it developed in areas where syphilis, malaria or scurvy was present, which along with the raw climate, high position of the ground, bad ventilation in a valley shut in by high hills, and the condition of the water which was greatly contaminated by

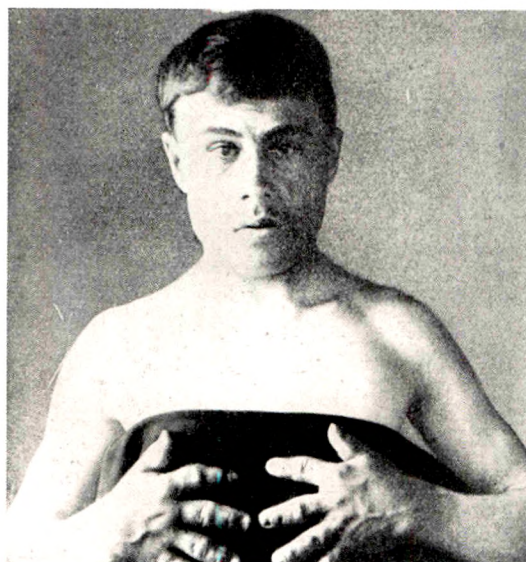


FIG. 1. Kashin-Beck's disease showing the bear's paw deformity (after Schipatschoff).

manure, were the chief causes of the disease.

Little notice was taken of his writing until Beck² in 1906, following the teachings of Kashin, pointed out that the water was the root of the whole trouble.

The clinical appearance of the disease is as follows: In the early stages it is not easy to diagnose. Pains in the joints, and tearing sensations in the muscles are the first symptoms; large and small joints are equal-

² Bek, E. V. Arthritis deformans in the province beyond the Baikals. *Russk. Vrach.*, 1906, 5, 74.

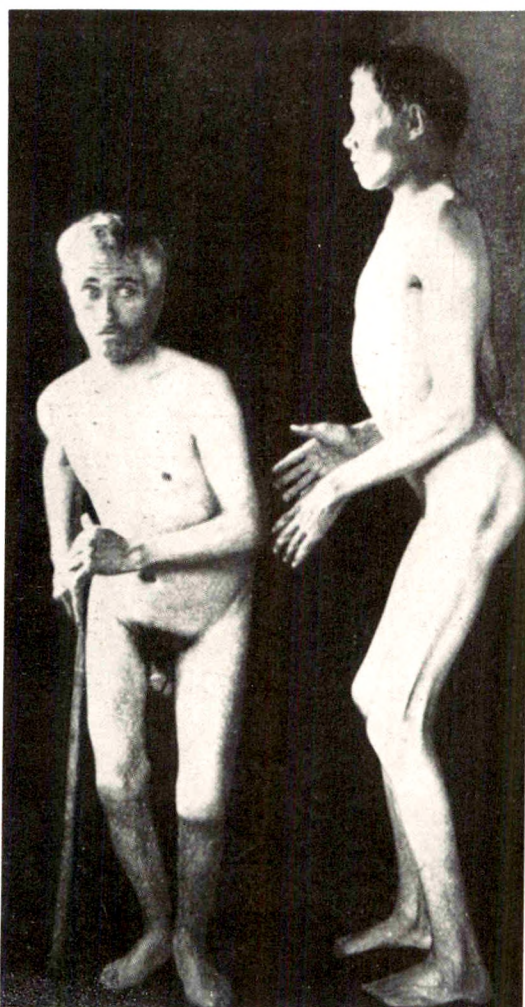


FIG. 2. Kashin-Beck's disease showing two patients with the disease fully developed (after Schipatschhoff).

ly affected; the joints swell, hemorrhagic spots appear in the skin, the temperature rises accompanied by a profuse perspiration; in fact, it appears like acute joint rheumatism. The acute stage passes and deformities appear, which are chiefly at the ends of the bone; the disease is symmetrical, but the right side may be more deformed than the left. It is more frequent in men than in women. Children may be born with the disease. Atrophy of a muscle or group of muscles may occur. The extremities are often shortened, reminding one of a bear's paw. It is frequently associated with goiter. The gums are spongy, and bleeding

takes place easily. Teething is late and children are rachitic. Rachitic rosaries are found and the development of the body is retarded.

The importance of dirty water as a cause of the disease was pointed out by both Kashin and Beck, and to prove this point experiments were carried out on young growing dogs which had drunk water out of the River Unda, which was greatly contaminated with manure. Arrest of growth followed and the dogs grew thin. Microscopic changes were found in bones, muscles, spleen, thymus, thyroid and other organs. The changes in the bone resemble arthritis, but there is marked rarefaction, and the cortex is thinned and the bones become shortened. There is a resemblance to rickets and scurvy; in fact, the disease appears to combine rickets, scurvy and polyneuritis, and Kashin in his original description said that scurvy passed into rheumatism. The changes already noted in human bones are found in animals in the endemic area, namely, cows, calves, sheep,

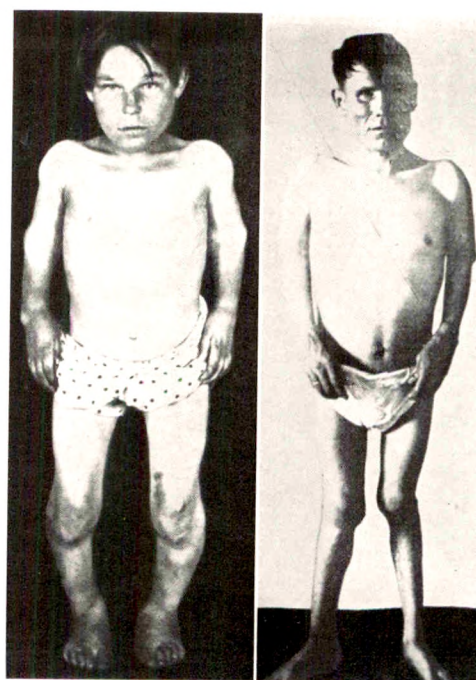


FIG. 3. Kashin-Beck's disease. Two front views of two patients with the disease (after Schipatschhoff).

dogs, cats, hens and doves. Examination made of nine patients suffering from the disease showed greatest changes in the skeleton, and many histologic changes in the internal organs.

The disease may be due to want of vitamins, and to prove this theory chemical investigations were carried out by Professor Balladins in the Ukrainian Biochemical Institute. The wheat of the harvest of 1926 was analyzed, and increase was found in creatin, and a lack of mineral salts, and the vitamins were not sufficient for the proper growth of the animals. Bread taken from the endemic area produced changes in animals similar to those seen in man. Histological changes were also visible, and the bones changed as in Kashin-Beck's disease. The grain does not ripen properly owing to the cold climate and the high elevation of the endemic area, so formation of vitamins is lacking, or poison may be present in the unripe grain.

The one-sidedness of the nourishment of the inhabitants plays a rôle; they must do without vegetables for five to six months, therefore water and food are considered the real factors in the progress of Kashin-Beck's disease.

The prognosis of Kashin-Beck's disease is unfavorable when the patient remains in the endemic area, and the disease disappears without treatment when the patients move out of the area. If they remain in the district they become chronic invalids.

It is fortunate that in North America, at least up to the present, we have not experienced the discomforts which these people in Siberia have to encounter, and thus the disease is unknown here. One could imagine that a child suffering from scurvy

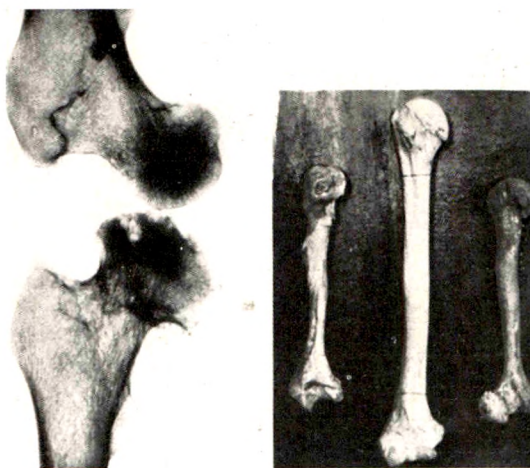


FIG. 4. Kashin-Beck's disease showing its resemblance to osteoarthritis (after Schipatschhoff).

if kept alive and allowed to grow with a defective diet which would keep the disease progressing would develop such deformities as are seen in Kashin-Beck's disease. The diet of patients with Kashin-Beck's disease consisting of unripened grain, no vegetables, and polluted water, is not one likely to be used in this country so it is not surprising if cases of this disease are not seen here.



RENAL RICKETS*

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BOSTON, MASSACHUSETTS

RENAL rickets is a term used to denote rachitic bone changes sometimes associated with chronic nephritis in children. It is not a primary entity, but a manifestation of disturbed mineral metabolism resulting from kidney disease.

This paper is concerned particularly with the question of its relation to rickets in general and with certain features of the bone lesions which are or may be of diagnostic significance.

Rickets as ordinarily seen in infants and as produced in animals is a deficiency disease, i.e., certain vital factors essential to the anabolism of bone are lacking.

McCollum and his coworkers⁷ proved the existence of a specific calcifying substance which is known as vitamin D. It is present in some foods, particularly abundant in cod-liver oil and can be produced by irradiation of certain fats including those normally found in the skin.^{3,4}

According to the work of Park, Guy and Powers,¹⁰ this vitamin acts as a regulator of calcium and phosphorus metabolism and permits the organism to operate with greatly increased economy with respect to these minerals.

In rachitic infants, the inorganic phosphorus of the blood is usually considerably reduced. The calcium may be normal or only slightly diminished.⁵ In some cases, however, the calcium is low and the phosphorus elevated.¹⁵

Shipley, Park, McCollum and Simmonds¹³ showed experimentally that, in the absence of vitamin D, rickets could be produced either by diminishing the phosphorus in the diet and supplying an optimum or excess of calcium or by reducing the calcium and maintaining the phosphorus at or near optimal concentration.

These same investigators⁸ brought out

evidence to show that the ratio between calcium and phosphorus in the diet is of infinitely greater importance in insuring normal calcification than the absolute amounts of these salts. This point was recently emphasized by Bethke, Kick and Wilder.¹ The most favorable Ca:P ratio for growth and bone formation is between 2.00 and 1.00. The vitamin D requirements at these proportions is at a minimum.

Summarizing the results of some of their previous experiments, Kramer and Howland⁶ state that the concentration of calcium and inorganic phosphorus in the serum is determined by at least four factors, namely, the calcium content of the diet, its total phosphorus, the ratio of these components in the diet, and the amount of vitamin D preformed or produced by irradiation. Without the balancing effect of vitamin D, the calcium and phosphorus in the serum varies directly with concentration of the same elements in the diet. Furthermore, there seemed to be an antagonism between calcium and inorganic phosphorus. A high concentration of one element depressed the other component in the serum.

Binger² had previously shown that the intravenous injection of phosphate solutions caused a drop in the serum calcium from normal of 10 mg. per 100 c.c. to approximately 6 mg.

The foregoing data as part of an extensive literature on the subject are quoted to show that the primary factor responsible for the bone changes of rickets is an imbalance or deficiency of calcium and phosphorus in the blood. The pathognomonic histological lesion is due to defective mineralization of growing bone.

It therefore seems reasonable to expect that any factor or factors that are capable

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of sufficiently disturbing the levels of calcium and phosphorus in the blood can cause rickets to develop in growing bone.

Vitamin D is the regulator and economizer of these elements, but to say that its presence in sufficient or even excess amounts can always insure normal calcification would be contrary to experience. In other words, under some circumstances, calcium and phosphorus metabolism may be so disturbed that vitamin D cannot rectify it.

Kidney disease is recognized as one of the factors that serve to alter the levels of the inorganic constituents of the blood. Peters and Van Slyke¹² state that in cases of ne-

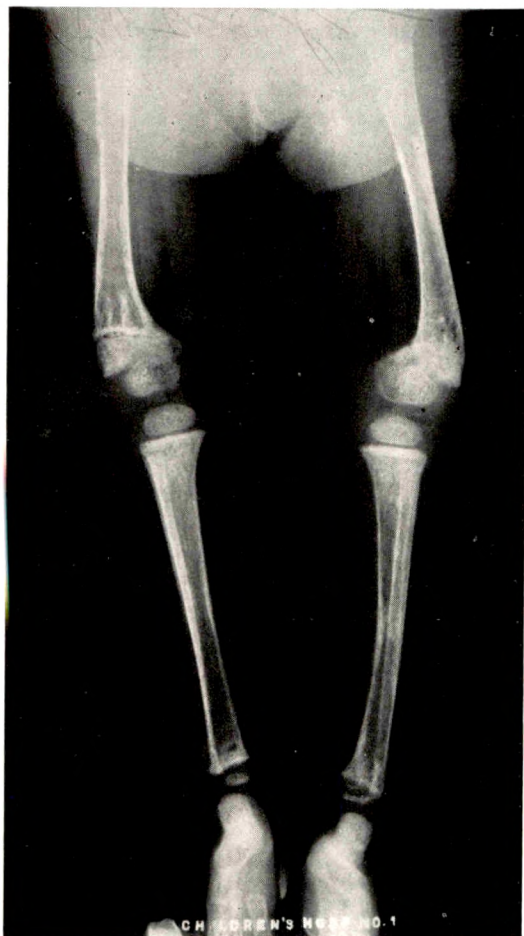


FIG. 1. Case 1. Note the broad mottled zones at the lower ends of the femora, due to defective calcification and inclusion of cartilage islands. Infractures have occurred through this poorly formed bone. Compare with Figure 2.

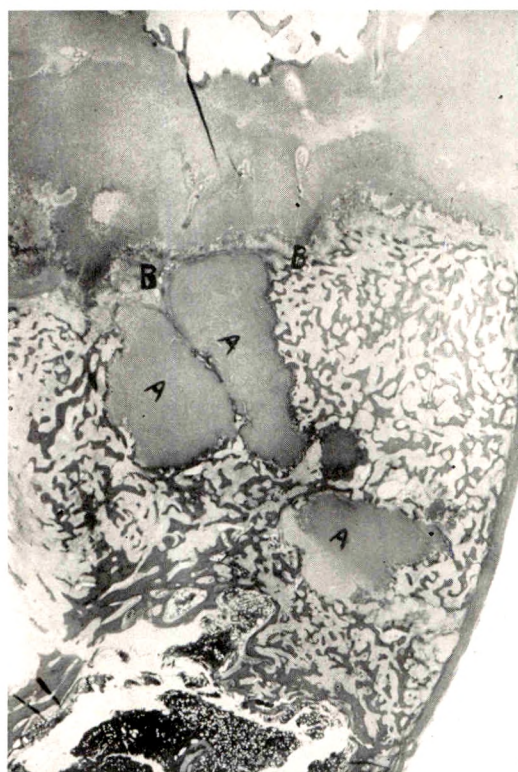


FIG. 2. Case 1. Low power photomicrograph from section through lower end of the right femur. A, A, A, large islands of uncalcified cartilage. Osteoid is relatively slight in amount. B, B, irregular zone of provisional calcification. There is an excess of fibrous tissue between the trabeculae.

phritis which present gross retention of nitrogenous waste products in the blood, the inorganic phosphorus of the serum is abnormally high, and whenever the inorganic phosphorus is consistently above normal limits, calcium is proportionately reduced.

Therefore, in certain types of nephritis conditions are present which are favorable for the development of rickets.

Quite recently Mitchell⁹ thoroughly reviewed the subject of chronic nephritis in children. He states that small stature and stunted growth almost invariably accompany chronic kidney disease in early life. This stunting is sometimes referred to as renal dwarfism. Abnormal bone changes were recognized in only about 40 per cent of the cases which he collected.

From the standpoint of function, the

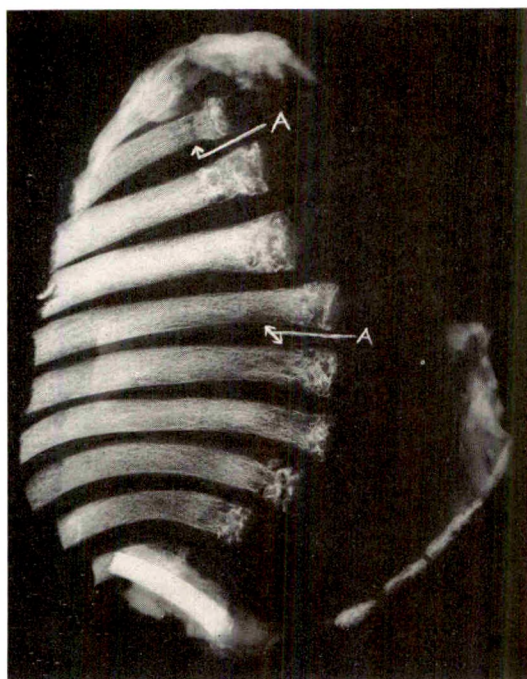


FIG. 3. Case 1. Roentgenogram of ribs, post mortem, showing irregular mottling of anterior ends and defective subperiosteal calcification along the lateral margins.

important feature is an advanced renal insufficiency; these children usually die in uremia, seldom reaching adult life.¹¹

When examined post mortem, the common kidney finding is chronic interstitial nephritis or nephrosclerosis, but other conditions are also encountered, such as polycystic kidneys, pyelonephritis and defective kidney development. Calculi are also reported.

Detailed histological studies of the bones have been made in relatively few cases. That the changes may differ in some respects from those usually seen in rachitic infants is to be expected. Growth is retarded, so osteoid is less abundant and may be only slight in amount. By the time these patients die the condition has usually been present for a long time and the changes in the bones are chronic. There may have been alternate periods of healing or partial healing and relapse. Irregular islands of incompletely calcified cartilage become included in the poorly formed new bone while con-

siderable fibrous tissue fills the interstices. This causes weakening where as the result of muscular activity and weight-bearing infractions are apt to occur.

The roentgenological changes correspond in a gross way with the microscopic picture. Findings vary a great deal in the different cases and sometimes in the same case at different times. Skeletal development is always retarded and growth disturbances are often manifested by the presence of transverse striae near the ends of the long bones. In some cases there is a zone of osteoid at the growing ends which is in no way different from that seen in ordinary rickets. Usually, however, there is something atypical about the picture. The lesions may be asymmetrical or different bones unequally involved.¹⁴ When the process has existed for a long time, there is a deep mottled zone at the ends of the long bones consisting of osteoid, islands of cartilage, fibrous tissue and partially calcified matrix. Distortion, infractions and bizarre deformities result.

Teall¹⁴ has called attention to superficial defects that sometimes occur along the shafts of the long bones, which he describes



FIG. 4. Case 1. Skull plate, post mortem, showing fine granular mottling and generalized osteoporosis.

as an eaten away appearance, and considers a most important feature from a diagnostic standpoint. These as indicated by microscopic study and as judged by the roentgenological appearance are due to defective calcification of subperiosteal growth. This is comparable to the defective subperiosteal calcification commonly seen in ordinary rickets, and also sometimes seen along the diaphyseal margins of young patients with hyperparathyroidism.

Parsons¹¹ and Teall¹⁴ have also described what they call a woolly appearance of the skull with marked thickening of the vault in advanced cases. Our cases have all shown generalized osteoporosis and finely granular cranial bones. The difference is probably a matter of degree or severity. Microscopically, there is a considerable amount of fibrous tissue dispersed between the bony trabeculae.

CASE REPORTS

CASE I. L. R., white female, aged two and a half. She neither walked nor talked, and weighed 13½ pounds. Urine showed a trace of albumin and many pus cells. Blood N. P. N. 150 mg. per cent. Phenolsulphonphthalein elimination practically nil in two hours. Serum calcium 6.2 mg. per 100 c.c. and inorganic phosphorus 5.3 mg. Plasma phosphatase 9 units (normal 3).

Roentgenograms showed changes of chronic rickets which did not improve with 3 drams of



FIG. 5. Case III. The zones of osteoid at the ends of the diaphyses are identical in appearance with ordinary rickets.

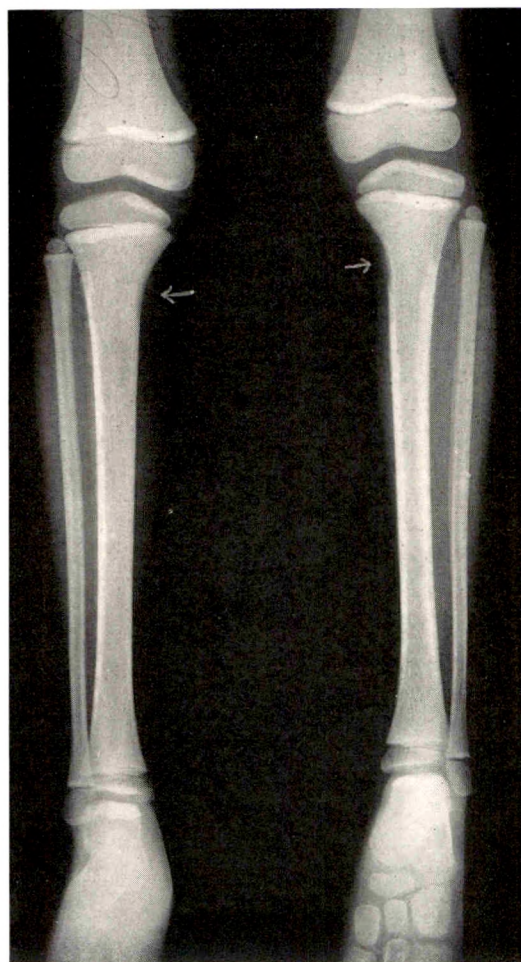


FIG. 6. Case V. Defective subperiosteal calcification at the upper ends of the tibiae medially, eaten away appearance. The metaphyses are smooth and dense.

cod-liver oil daily and she died after two months in the hospital.

Necropsy* revealed extensive bronchopneumonia. Kidneys were small, contracted and fibrotic with widespread chronic inflammatory cell infiltration in interstitial tissue. The parathyroids were hyperplastic but no adenoma present. Adrenals contained numerous microscopic intracortical adenomata.

CASE II. A. S., white girl, aged nine, admitted on account of puffiness of face, headaches and convulsions. Symptoms dated back an indefinite period, probably to birth. She was anemic, undersized and mentally retarded. Urine showed a trace of albumin and many pus cells.

* Pathological report by Dr. Sidney Farber.

Phenolsulphonphthalein elimination almost nil. Blood N. P. N. 188 mg. per cent. Serum calcium 7.6 mg. per cent and inorganic phosphorus 5.6 mg. per cent. Roentgenograms showed a broad zone of osteoid at the ends of all the long bones, characteristic of rickets.

CASE III. S. K., white girl, aged nine and a half, pale, weak and physically retarded. Was known to have albumin and pus in the urine for several years. Blood N. P. N. 200 mg. per cent. Died in uremia. No necropsy (see Fig. 5).

CASE IV. S. B., white female, admitted first at eighteen months of age with fever, vomiting and pyuria. Pyelograms showed a large hydro-nephrotic right kidney. The left, as proved by operation, was congenitally absent. Blood N. P. N. was 46 mg. per cent and phenolsulphonphthalein elimination less than 10 per cent in two hours. She first began to walk at $2\frac{1}{2}$ years when it was noticed that her ankles turned in and she had knock-knees. Roentgenograms showed a broad zone of osteoid and mottled new bone at the lower ends of the tibiae and fibulae through which there were incomplete fractures. The epiphyses turned outward. There was also moderate mottling of the metaphyseal

margins of the radii and ulnae. She had been getting cod-liver oil (amount not stated) but in the hospital with 3 drams daily and direct sunlight, the lesions definitely improved.

CASE V. R. S., white female, aged seven. Chief complaint was failure to grow and develop. Urine showed a trace of albumin. Blood N. P. N. 133 mg. per cent and renal function too low to be estimated. Serum calcium 10.1 mg. per 100 c.c. and inorganic phosphorus 6.9 mg. Note: This child did not have the typical zone of osteoid at the ends of the long bones, but she did have defective subperiosteal bone growth (Fig. 6).

DISCUSSION

For the diagnosis of renal rickets, two conditions have to be established, namely, rachitic bone lesions and chronic nephritis. The patient may first come to the attention of the physician on account of the skeletal deformities. More often, however, the chief symptoms point to renal damage.

Roentgenograms are of the greatest value in determining the nature of the bone changes in the living, but one is seldom warranted in making an etiological diagnosis from the films alone. If the bone lesions are atypical or if the patient is beyond the age when rickets usually occurs, suspicion should be directed towards the kidneys as a possible cause. Changes of rickets are sometimes found in the roentgenograms of children known to have chronic nephritis although they may not have been clinically recognized. Since the roentgen ray has come into general use as a diagnostic aid, cases are being reported more frequently.

Rickets resulting from kidney disease usually does not respond to the administration of vitamin D, but from some reported cases^{3a} and from our own experience, it is probable that this substance may sometimes increase calcification. The kidney disease causes an imbalance of calcium and phosphorus in the blood. Vitamin D is a regulator of calcium and phosphorus metabolism. If the imbalance is not too great, vitamin D may correct it sufficiently to improve or even cure the rickets temporarily.

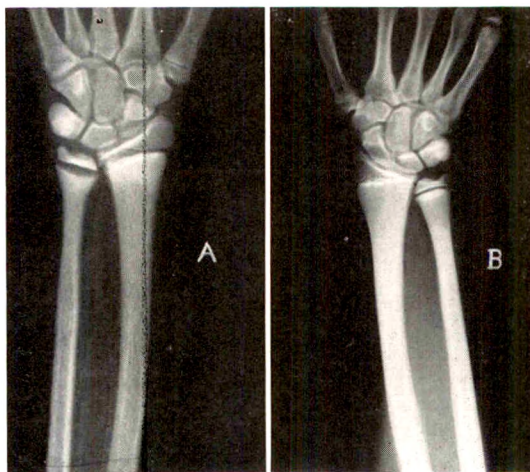


FIG. 7. Hyperparathyroidism in a boy aged fifteen. Roentgenogram (A) was made when the serum calcium was 19.4 mg. per 100 c.c. and inorganic phosphorus 4.0 mg. Note the rachitic zone of osteoid at the metaphyses and the generalized osteoporosis. Roentgenogram (B) was made four months after the surgical removal of a large parathyroid adenoma (3×4 cm.) and the serum calcium and inorganic phosphorus had returned to normal levels. The bones are now well ossified. (This case is presented through the courtesy of Dr. M. C. Sosman of the Peter Bent Brigham Hospital.)

Further evidence that a severe imbalance of calcium and phosphorus of the blood even in the presence of vitamin D is seen in cases of hyperparathyroidism. Parathyroid disease occurs more often in the age period after growth has ceased, and then osteitis fibrosis osteoplastica (von Recklinghausen's disease) is the common manifestation in bone. However, if the bone is actively growing, rachitic changes may develop (parathyroid rickets).

Therefore, from the roentgenological standpoint, we have at least three conditions to consider in the differential diagnosis, namely, rickets the deficiency disease,* renal rickets and parathyroid rickets.

* Coeliac rickets as described by Parsons¹¹ would be included here under rickets the deficiency disease.

As evidence of renal disease, there is usually albumin in the urine and there may be pus. Functional tests show an advanced renal insufficiency and retention of nitrogenous waste products.

The inorganic phosphorus of the serum is increased. The calcium may be normal, but is often reduced. The ratio between these elements in the serum is always unbalanced.

In uncomplicated hyperparathyroidism, the serum calcium is much increased, and the inorganic phosphorus usually low.

The plasma phosphatase is high in all types of rickets.

The ultimate diagnosis depends on the correlation of all available data, including history, clinical, roentgenological and laboratory findings.

REFERENCES

- BETHKE, R. M., KICK, C. H., and WILDER, W. The effect of calcium-phosphorus relationship on growth, calcification, and blood composition of the rat. *J. Biol. Chem.*, 1932, 98, 389-403.
- BINGER, C. Toxicity of phosphates in relation to blood calcium and tetany. *J. Pharmacol. & Exper. Therap.*, 1917-1918, 10, 105-120.
- CLOUSE, RUTH C. Vitamin D. *J. Am. M. Ass.*, 1932, 99, 215-222; 301-309.
- a. GYÖRGY, P., and SCHICK, B. Quoted by Mitchell, ref. 9.
- HESS, A. F., and WEINSTOCK, M. The antirachitic value of irradiated cholesterol and phyto-sterol. *J. Biol. Chem.*, 1925, 64, 181-191.
- HOWLAND, J., and KRAMER, B. Calcium and phosphorus in the serum in relation to rickets. *Am. J. Dis. Child.*, 1921, 22, 105.
- KRAMER, B., and HOWLAND, J. Factors which determine the concentration of calcium and inorganic phosphorus in the blood serum of rats. *J. Nutrition*, 1932, 5, 39-60.
- MCCOLLUM, E. V., SIMMONDS, N., BECKER, J. E., and SHIPLEY, P. G. Studies on experimental rickets; an experimental demonstration of the existence of a vitamin which promotes calcium deposition. *J. Biol. Chem.*, 1922, 53, 293-312.
- MCCOLLUM, E. V., SIMMONDS, N., SHIPLEY, P. G., and PARK, E. A. Studies on experimental rickets; production of rickets by diets low in phosphorus and fat-soluble A. *J. Biol. Chem.*, 1921, 47, 507.
- MITCHELL, A. G. Nephrosclerosis (chronic interstitial nephritis) in childhood, with special reference to renal rickets. *Am. J. Dis. Child.*, 1930, 40, 101.
- PARK, E. A., GUY, R. A., and POWERS, G. F. A proof of the regulatory influence of cod liver oil on calcium and phosphorus metabolism. *Am. J. Dis. Child.*, 1923, 26, 103-111.
- PARSONS, L. G. The bone changes occurring in renal and coeliac infantilism, and their relationship to rickets; renal rickets. *Arch. Dis. Childhood*, 1927, 2, 1-25. Also: Bone changes occurring in renal and coeliac infantilism, and their relationship to rickets; coeliac rickets. *Arch. Dis. Childhood*, 1927, 2, 198-211.
- PETERS, J. P., and VAN SLYKE, D. D. Quantitative Clinical Chemistry. Williams and Wilkins Co., Baltimore, 1931.
- SHIPLEY, P. G., PARK, E. A., MCCOLLUM, E. V., and SIMMONDS, N. Is there more than one kind of rickets? *Am. J. Dis. Child.*, 1922, 23, 91-106.
- TEALL, C. G. A radiological study of bone changes in renal infantilism. *Brit. J. Radiol.*, 1928, 1, 49-58.
- TISDALL, F. F. The calcium and phosphorus concentration in the serum of infants with mild rickets or a condition simulating mild rickets. *Am. J. Dis. Child.*, 1922, 24, 382-386.

DISCUSSION

DR. P. F. MORSE, Detroit, Mich. These cases of renal rickets are of extraordinary interest relative to the parathyroid question. A recent case on which I did a post mortem was a boy with a typical clinical history of hypertensive nephritis. At the post mortem the combined weight of the two kidneys was 65 grams. He was seventeen years of age. One kidney weighed 25 grams and the other 40. The skeleton everywhere could be excised freely with the knife without the aid of a saw. We cut his calvarium off with a large knife. We excised certain of the vertebral bodies. We cut out a big piece of the femur and of the arch of the pubes all freely with the knife without any grating or signs of lime salts left. That boy had the largest parathyroid we have ever seen, and incidentally extreme basophilia of the hypophysis. We regard both of those changes as compensatory.

Dr. Vogt has shown you what I believe to be absolutely the underlying feature of renal rick-

ets, and that is a high blood phosphate. Albright and Howe and their coworkers have shown that a high blood phosphate experimentally introduced into young animals always produces compensatory hypertrophy of the parathyroid. The change here is probably hyperphosphatemia, and it usually leads to parathyroid stimulation, and then to the secondary effect. It is merely an interesting pathological entity.

Therapeutically considered, there is not much to be hoped for because by the time any of us see these cases the kidney changes have gone on to an extent which makes it impossible to consider any form of treatment whatever.

I think of the high blood phosphate as being the background for all the other things, and the parathyroid changes, and the hypophyseal changes, and the bone changes as resulting eventually from that high blood phosphorus.



OSTEOGENESIS IMPERFECTA*

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BRYN MAWR, PENNSYLVANIA

OSTEOGENESIS imperfecta has been defined by Knaggs as the disease which is characterized by a congenital defect in the evolution of the osteoblast, and which is recognized clinically by defective ossification of the cranium and multiplicity of fractures resulting from trivial causes. Various synonyms have been employed in the terminology of this disease, such as fragilitas ossium, idiopathic osteopsathyrosis, osteogenesis imperfecta, periosteal aplasia, maladie de Lobstein, and so forth. Various classifications of types and forms have been suggested. Prussak and Mesz state that the late variety of the disease was known before Lobstein (1833) described it as the latter cited several other authors, but credit is due him for giving it a definite place in medical literature and for presenting the first anatomical description of the condition. He regarded the fragility of the bones as a symptom of other conditions, suspecting carcinoma, rickets, scurvy and gout as possible underlying causes.

PATHOGENESIS

Practically all authors are agreed that the main and essential histological finding is a deficiency of osteoblasts, resulting in deficient ossification of bone, this being productive of numerous and repeated fractures. On chemical analysis there is no lack of the inorganic constituents of bone, and fragility cannot therefore be dependent upon this factor. The cause of the fragility must be sought elsewhere.

Since this paper forms a part of a symposium on the osteomalacic diseases of bone, calcium and phosphorus metabolism is naturally first thought of in connection with the pathogenesis of the condition. Wyatt and McEachern (1932) have lately

reported a case in which there was marked congenital bone dysplasia and unusual vascularity of the parathyroid glands with a relatively small amount of parenchymal tissue, and they suggest the possibility that osteogenesis imperfecta may sometimes be based in part on a congenital parathyroid disturbance. This is apparently the sole reference in the literature to an actual pathological finding in the parathyroids in such a case.*

Bookman (1914) reported a slight decrease in the calcium retention as compared with the normal in a study of a patient, aged ten weeks, but a positive calcium balance was still maintained. Wagoner (1924) reported normal calcium and phosphorus content of the blood plasma and normal content of inorganic salts of the bone of the biopsy specimens removed from his patient. Flagstad, Zanger and Leven (1924) in a preliminary study also reported normal phosphorus and calcium values of the blood serum. In Wyatt and McEachern's case, no complete study of the calcium balance could be made. The content of calcium and phosphorus in the bone ash and the ratio between them were normal. The definite increase in the amount of sodium in the ash suggested to them a relative decrease in the amount of calcium phosphate per unit of bone. On the presumption that

* Since this was written, my attention has been drawn to the paper of Donald Hunter on "Calcium and Phosphorus Metabolism," *Lancet*, 1930, 1, 999-1008. He states: "In osteogenesis imperfecta no abnormality in the serum calcium, plasma phosphorus or calcium output has been satisfactorily demonstrated. The plasma phosphatase is in some cases, slightly raised. The cause of the defective osteoblastic apposition of bone is quite unknown. There are two cases recorded which showed enlargement of the parathyroids. The seven month foetus described by Bauer had four enlarged parathyroids, the largest, the size of the adult gland, (3 mm. diameter). Histologically, these showed hyperplasia. He relates that Dietrich described another case. In the present state of our knowledge such observations are without explanation."

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

the bones never had their normal content of calcium salts, they suggest that possibly this factor could explain calcium and phosphorus levels in the blood which differ from those usually found in the parathyroid disturbance of later life.



FIG. 1. Osteogenesis imperfecta congenita. Typical "gnarled" appearance of the bones of the extremities. Deformities due probably to intrauterine fractures.

Before the publication of Wyatt and McEachern's case, the deficiency of osteoblasts was emphasized as a causative factor by most workers. Knaggs summarized the histological changes as follows: (1) the stages of cartilaginous ossification are normal up to the formation of the primary areolae; (2) the periosteal and medullary ossification is quite abnormal in character, deficient in quantity and inferior in quality; (3) osteoblast edging to the trabeculae is either absent altogether or only partially present. In the long bones, he drew attention to three important variations from normal: (1) in the formation of bone from the cartilaginous epiphysis the first departure from the normal process of ossification is the formation of trabeculae by the calcification of the cartilage and their extension by metaplasia of the adjoining connective

tissue of the marrow; (2) intimately associated with this, and without doubt the cause of it, is the complete absence of rows of osteoblasts; (3) in the formation of bone under the periosteum is found the factor of the production by the periosteum of cartilage cells instead of osteoblasts.

Fairbank (1930) questions these causative factors, inasmuch as osteoblasts are found in the callus formed about the pathological fractures. He thinks the large cartilage cells formed by the periosteum instead of osteoblasts are no more than an occasional change, found here and there; nor does he regard it as strange for these cells to be present in large quantities since the periosteum itself is derived from the perichondrium, and cartilage cells are presumably derived from the periosteal cells found in callus of all ages.

The apparent lack of osteoblast formation has led to the theory of a congenital malformation of the bone-forming system, the disturbance occurring as a fault in mesoblastic differentiation inasmuch as osteoblasts, themselves connective tissue cells, are derived from the primary mesoderm. Knaggs so regards it and Weber (1930), more recently, has claimed that the formation of lamellar bone does not occur. The arrest of growth is a primary condition and the highest stage of bone development is entirely lacking. The origin of this growth disturbance is traceable far back into the intrauterine period. It differs from osteitis fibrosa cystica in that the latter involves a formerly normal skeleton and is thus a secondary dystrophy, whereas osteogenesis imperfecta is a congenital primary generalized arrested malformation of the bone-building system.

Endocrine disturbance, other than the parathyroids, has been suggested as a possible cause. Against this theory, however, is the fact that no pathological changes have been found in the thyroids and in other endocrine glands at autopsy. As Foote (1927) has pointed out, the hereditary nature of the disease is an argument against the endocrine theory since such failure

would have to be functional in the absence of actual reported pathological changes in the endocrine glands at autopsy. Functional disability of organs does not seem to be an inheritable trait. Gorter found that rapid improvement of symptoms followed treatment with thymus in two cases, using in one, fresh pig thymus and in the other compressed thymus gland. Ryan (1932) reported two cases, the patients having ceased to have fractures while thymus extract was administered. No metabolic studies were made, however, during the course of treatment. Fairbank has offered the suggestion that further work with phosphatase may throw some light on the pathogenesis of the condition.



FIG. 2. Male, aged five months. Numerous fractures of the long bones and ribs. Negative blood Wassermann. Apparently osteogenesis imperfecta, although the dense bands at the diaphyseal extremities resemble somewhat marble bones or Albers-Schönberg's disease, which is included by Fairbank under the general heading of osteogenesis imperfecta.



FIG. 3. Skull of same patient as Figure 2. Irregular ossification along the suture lines producing a mosaic appearance as described by Knaggs.

CLASSIFICATION

The disease appears at various periods of life, with varying degrees of severity and with varied clinical manifestations. Thus, clinical and pathological classifications also vary. Knaggs describes the fetal, the infantile, the childhood and adolescent varieties and finally the type found in later middle life. From a pathological standpoint, Fairbank classifies the disease into the thick bone type; the slender, fragile bone type; the marble bone type (Albers-Schönberg's disease) and the honey-comb type.

Key mentions three idiopathic types of bone fragility: (1) osteopsathyrosis described by Lobstein in 1833 as a clinical entity; (2) osteogenesis imperfecta described by Vrolik in 1849 as a separate condition; (3) the syndrome of brittle bones and blue sclerae described by Spurway in 1894. The accompanying symptom of blue sclerae will be more fully discussed later. Key uses this symptom as a basis for his classification inasmuch as he regards it as evidence of congenital hypoplasia of the mesenchyme. He divides the condition into the following types:

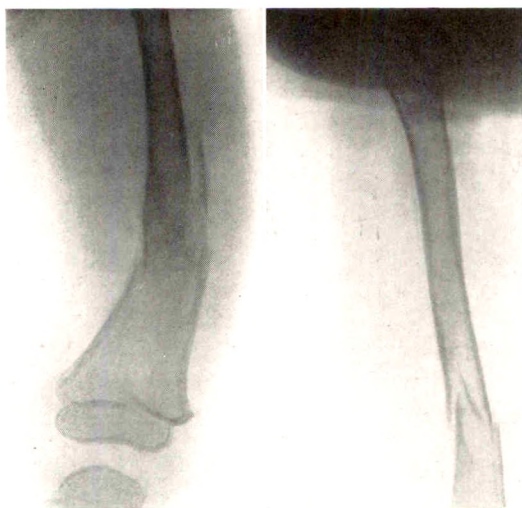


FIG. 4. Osteogenesis imperfecta tarda. Male, first fracture at two and one-half years of age. Has been under observation five years. Marked rarefaction and atrophy of the bones of the extremities. Blue sclerae. Mother also has blue sclerae with tendency to fracture on slight provocation. Normal serum calcium and phosphorus. Has been admitted to hospital four times for fractures of various bones.

1. Hereditary form, hereditary hypoplasia of the mesenchyme.

2. Non-hereditary forms: (a) osteogenesis imperfecta; (b) osteopsathyrosis with white sclerae; (c) osteopsathyrosis with blue sclerae.

3. Probably not hereditary, osteosclerosis fragilitas generalisata or marble bones.

Osteogenesis imperfecta of the congenital type is regarded by him as not hereditary. No case of osteogenesis imperfecta has been recorded in any one of the families afflicted with hereditary hypoplasia of the mesenchyme. This latter seems to him to be an anomaly of development rather than a derangement of metabolism. The hypoplasia is apparently limited to those tissues derived from the mesenchyme. He has never found any evidence of endocrine disturbance. He thinks it better to regard osteogenesis imperfecta and idiopathic osteopsathyrosis as separate conditions because they present different clinical pictures although they may have the same pathologic basis. From his analysis of the literature he

finds that blue sclerae are the only feature of hereditary hypoplasia of the mesenchyme which is transmitted as a dominant hereditary trait.

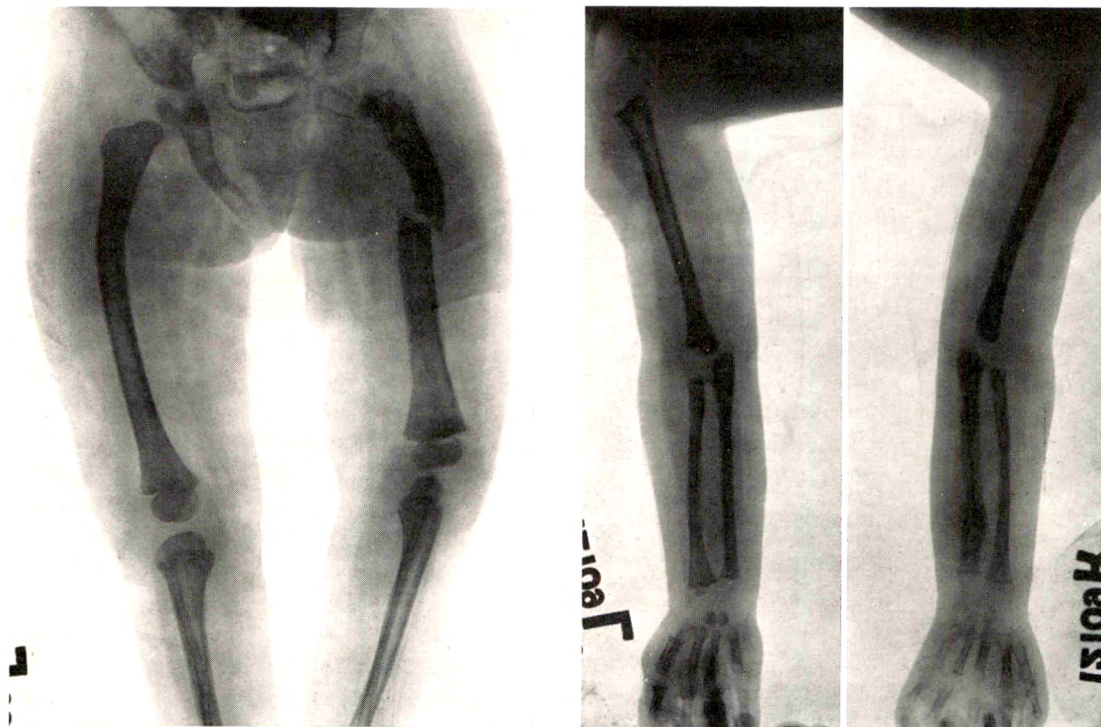
Osteogenesis Imperfecta Congenita. In this form the patient shows at birth evidence of the disease, the majority being born with numerous fractures. The extremities are usually deformed, noticeable immediately after birth; curvatures and nodular prominences are present. The thorax is often misshapen and nodules, due to the presence of intrauterine fractures with callus formation, can be palpated. The nodules felt in the long bones are due to the same cause. Occasionally crepitations can be obtained. The skull on pressure is no thicker than parchment due to defective membranous bone development. Fairbank describes it as a membranous bag with a few small isolated areas of ossification. This has led to the term "rubber-ball head." Knaggs calls attention to the fact that the membranous areas which intervene between the immature bones are apt to become filled with numerous Wormian bones resulting from discrete patches of ossification. Remarkable appearances, he says, are thus produced, the vault being represented by a mosaic of larger and smaller bone plates, sometimes touching one another and sometimes united by bridges of periosteum and dura. Often, there is such a noticeable degree of lack of ossification that the skull can be moulded by the pressure of the hands. Its shape is not that of hydrocephalus nor do the skull and facies resemble those typical of achondroplasia. The nose is not short and stubby and the features are not coarse. There is no excessive subcutaneous fat over the bones and the skin does not lie in deep folds. The stem length of the infant is usually normal for its weight but the general body length is always below normal. If the child lives, profuse and continued sweating, beginning usually during the second week, is present. Petechial hemorrhages of the skin sometimes occur. Cyanosis as a symptom often develops and there may be a moderate rise

in temperature. If the infant does survive, he remains a chronic invalid during the rest of his life. Some cases show a cretinoid cast of countenance. In this category may be included the cases which show less severe symptoms at birth and survive for a year or two. By some authors these cases are classified under the heading, *osteogenesis imperfecta infantilis*, or the infantile type. It seems far simpler to include as *osteogenesis imperfecta congenita* all cases, whether or not they survive, who have shown signs of the disease at birth, or so soon after, that no doubt exists that defective intrauterine ossification was present.

Osteogenesis Imperfecta Tarda. Under this can be classed all cases variously described as *fragilitas ossium*, *osteopsathyrosis*, *adolescent osteogenesis imperfecta* and the type occurring in middle or later life. Foote describes an infantile type that appears after the child begins to walk or

stand without support. These children usually die comparatively early as a result of intercurrent infection. Very slight trauma may produce a fracture. As a rule, the earlier in life the fractures first occur, the greater is the liability to fracture. The fractures are usually subperiosteal and deformity is very likely to result from malposition of the fragments. There is a noticeable lack of pain which is probably accounted for by the subperiosteal nature of many of the fractures. Knaggs believes that in the cases in which the signs first appear in childhood or adolescence, the fundamental change was present in early uterine life. The less the defect, the greater is the likelihood that its signs will be delayed until the patient is able to get about and is exposed to the ordinary slight traumatism of the usually healthy life.

The late form which does not appear in infancy or early childhood, but is seen first



FIGS. 5 and 6. *Osteogenesis imperfecta tarda*. Female, first admission for fracture of the femur at age of eight months. Readmitted at two and one half years of age for fractures of femur and ulna. No blue sclerae nor hereditary history. Normal serum calcium and phosphorus. Child died of pneumonia at four years of age.

in early adolescence or later life, usually has an accompanying history of distinctly hereditary character. This may be due to the fact that more of these individuals live to a marriageable age. In some the tendency to fracture may be slight, in others it may be more pronounced. Severe cases often must spend their lives in a wheel chair. In the late form, the tendency to angulation and extreme bowing of the bones is sometimes not so marked. This, however, is variable inasmuch as bowing depends upon the number of fractures incurred by the individual.

An accompanying symptom of osteogenesis imperfecta tarda, in many cases, is the occurrence of blue discoloration of the sclerae. This is usually described as grayish-blue. Griffith and Mitchell credit Eddowes (1900) with the first mention of the blue sclerae, but Prussak and Mesz state that Ammon, an eye surgeon, had described it earlier, in 1891. The trait is often found in several members of the family, and sometimes in more than one generation. In each one who shows the blue discoloration, a history of multiple fractures can usually be obtained. The blue color (Knaggs) is due to the partial visibility of the pigmented choroidal tunic through the sclera. The cause of this color is still unsolved. It has been suggested that the fibrous tissue of the coat is abnormal and this tissue, arising from the mesoderm as do the osteoblasts, is affected by the same disturbance. Bronson has noticed a liability to sprain of joints in cases having blue sclerae with multiple fractures. Here, too, would be another connective tissue similarly affected. Fairbank warns that the term should be limited only to those cases in which definitely blue sclerae are noted. He has been able to find no relation between the depth of color of the sclerae to the number of fractures or to the severity of the disease. Max Schmidt (1925) proposed the term *leptoscleria* for the blue discoloration, because the use of the word "blue" suggests an actual blue color such as may be noted in cases of carbolic poisoning and alkaptosis,

while *leptoscleria* expresses the true condition, the extreme thinness of the membrane. Buchanan (cited by Blevgad) states that the coat is sometimes only one-third its normal thickness, and the blue appearance is due to the blood of the uvea shining through it.

Among other associated symptoms, Blevgad and Haxthausen have reported a case of a patient with blue sclerae, tendency to fractures, and in addition, zonular cataract and circumscribed atrophy of the skin.

Deafness is another associated symptom. It seems, however, from the cases reported in the literature, that this is not as frequent as the blue discoloration. The reason for this is most likely the fact that disturbances of hearing arise only after the age of puberty is reached. Most authors attribute it to an otosclerosis, but Le Mee thinks that it is due to the deformity of the skull which causes a slanting projection of the membrana tympani accompanied by relaxation of the ligaments of the ossicles of the ear.

PATHOLOGY

The essential histological changes have been described. The lack of ossification in the skull is more marked in the vault although the same change can be found to a lesser degree in the base. The facial bones are largely cartilage. The vertebrae and the pelvic bones do not fracture as easily as the skull, long bones and the ribs. The periosteum is thickened in the region of the fractures but is normal elsewhere. There is not much cancellous bone in the ends of the shaft. Foote points out that in the congenital form, if the patient survives, most of the abnormality centers in defective transverse growth unless epiphyseal separations occur.

ROENTGENOGRAPHIC APPEARANCE

In the congenital form the roentgen appearance of the entire skeleton is characteristic. The bones of the extremities have a gnarled, stubby, and thickened appearance. The cortex is thin. Callus deposits can easily be detected in the shafts at the site of fracture. The bones are bowed and mis-

shapen. The thorax is sometimes compressed and the ribs are bent, due to the numerous fractures. All bones usually show a marked degree of osteoporosis with the exception of the vertebral column. The tables of the skull are extremely thin and often calcification and ossification seem to be entirely lacking in some areas. Small indentations due to fractures are visible. There is sometimes a noticeable lack of calcification in the bones of the face, and the cartilage shadows can be detected in roentgenograms showing excellent soft part detail. Sutures and fontanelles are wide.

In the late form there is usually marked thinning of the cortex and bowing of the long bones of variable degree. Generalized



FIG. 7. Osteogenesis imperfecta tarda. No hereditary history nor blue sclerae. Normal serum calcium and phosphorus. Right femur broken ten times; left femur, twice; right humerus, three times; left arm, twice. Fractures united quickly with excellent callus formation.



FIG. 8. Same case as Figure 7. Marked atrophy of the bones of the lower legs. Widening of the metaphyses and epiphyses.

osteoporosis may be present. The marked atrophy of the shafts produces an appearance of widening of the metaphyses and epiphyses. This, however, is often more apparent than real, the illusion being created by the atrophy of the shafts. As a rule, the epiphyses are not widened. In the cases of this series the so-called foamy epiphyses, supposedly characteristic of this disease were lacking. The area of the diaphyso-epiphyseal junction is usually normal. Where epiphyseal separations have occurred there may be periosteal proliferation along the borders of the epiphyseal centers of ossification, but this also has not been noticed in this series of cases. Slight infractions of the periosteum occasionally can be seen. On later examinations callus form-

ation occurs in these areas. Transverse striations, small fine lines running through the metaphyses of the long bones, are sometimes noticed. In patients having fewer fractures, bowing and deformity are not so marked and often the only bone change is a noticeable atrophy as shown by the thinning of the cortex.

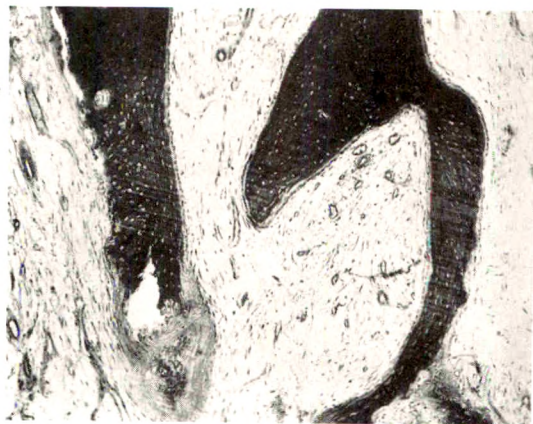


FIG. 9. Same case as Figure 7. Microscopical sections by Dr. Geo. W. Wagoner, Orthopedic Hospital; removed from femur near site of fracture. Osteoblast edging is present without the extreme lack of osteoblasts which usually occurs in osteogenesis imperfecta. Considerable fibrosis with a few giant cells; in many respects the appearance resembles osteitis fibrosa cystica.

DIFFERENTIAL DIAGNOSIS

From the roentgenographic point of view, there should be no difficulty in differentiating both the congenital and early infantile cases from rickets. The frayed-out diaphyseal extremities, the cupping, the moth-eaten appearance of the epiphyseal centers and the thinly striated shafts are not seen in osteogenesis imperfecta. The age incidence is also of importance as true fetal rickets has only been demonstrated in infants born of mothers suffering from osteomalacia. In the cases reported by Maxwell, Hu and Turnbull the roentgenograms showed no signs resembling those of the congenital type of osteogenesis imperfecta.

Achondroplasia presents the same short, thickened bones as osteogenesis imperfecta

but multiple fractures, callus formation, etc., are lacking in the roentgenogram. Clinically the latter is characterized by the large head with the saddle nose and thick, coarse features, whereas with osteogenesis imperfecta the infant has a small head of rubber-ball consistency and the facies are normal.

Congenital syphilis must be differentiated from osteogenesis imperfecta. Usually the fetus with widespread syphilitic changes in the skeleton in the roentgenogram has also more or less definite clinical signs. The roentgenographic changes of congenital syphilis are so characteristic that no difficulty should be encountered. Usually in the ends of the diaphyses of the long bones the typical changes of syphilitic osteochondritis can be found, such as increased density and width of the zone of temporary calcification, submetaphyseal rarefaction (McLean), double zones of temporary calcification, and in the late stages, fragmentation and disintegration of the metaphysis in the area adjacent to the zone of temporary calcification. Besides, numerous fractures do not, as a rule, occur in congenital syphilis.

From the later form of osteogenesis imperfecta, juvenile osteomalacia can be diagnosed clinically by the negative calcium balance. In osteomalacia, the deformity, as a rule, precedes the fracture; in osteogenesis imperfecta, the fracture precedes the deformity. The occurrence of osteomalacia in adolescence has never been proved and according to most authorities it should not be considered a disease of infancy and adolescence. The history, etc., together with the negative calcium balance should be diagnostic in cases which occur after full growth is attained.

Finally, a differentiation must be made from the "osteopsathyrosis due to avitaminosis." Heise has lately described a case of infantile scurvy accompanied by multiple fractures. He attributes the latter to the condition termed osteopsathyrosis due to avitaminosis first described by Czerny and Keller. This can occur either alone or in

connection with other diseases such as rickets and infantile scurvy in which there is a deficiency of vitamins. It has no apparent relation either to the congenital form of osteogenesis imperfecta or to the late form, idiopathic osteopsathyrosis.

COMMENT

This report is based upon a series of 4 cases of the early or congenital type and 4 cases of the late or tarda type. Of the 4 congenital cases, only one showed a slight bluish discoloration of the sclerae. Of the late cases, one patient showed this sign, whose mother also had blue sclerae and a history of tendency to fracture on slight provocation. In none of them was deafness observed, probably due to the fact that they had not reached adult life. In one of the cases, metabolic studies are to be published later. Since this symposium is concerned with the roentgen appearance and diagnosis of this condition, its treatment has not been mentioned.

One of the outstanding points in the roentgenographic appearance of the cases

studied was the absence of widened and foamy epiphyses, entirely lacking except for a slight tendency in one case (Fig. 7). Another point is the appearance of wide dense bands near the diaphyseal extremities which resembles that of marble bones or Albers-Schönberg's disease. This case would seem to justify the inclusion by Fairbank of marble bones as one of the groups or types of this disease entity. In one of the congenital cases calcium deposition occurred along the irregular and serrated suture lines of the skull, as described by Knaggs, producing an appearance of numerous, small islands of calcification, which suggests that this, in a certain proportion of cases, is a characteristic roentgen picture of the disease in the congenital type.

I wish to express my appreciation to Dr. Joseph Stokes, Children's Hospital, Dr. Vincent Curtin of the Episcopal Hospital, Dr. Deforest P. Willard and Dr. Geo. W. Wagoner of the Orthopedic Hospital for permission to study the cases taken from their services, and to Dr. Geo. W. Wagoner and Dr. Irvin Stein, Orthopedic Hospital, for their help and suggestions in the preparation of this paper.

REFERENCES

1. BOOKMAN, A. The metabolism in osteogenesis imperfecta with special reference to calcium. *Am. J. Dis. Child.*, 1914, 7, 436-444.
2. BRONSON. Quoted by Knaggs, ref. 11.
3. CZERNY and KELLER. Die Kindes Ernährung, etc., 1925. Quoted by Heise, ref. 10.
4. EDDOWES. *Brit. M. J.*, 1900, 2, 222. Quoted by Griffith and Mitchell, ref. 9.
5. FAIRBANK, H. A. T. Some remarks on osteogenesis imperfecta. *Proc. Roy. Soc. Med. (Sect. Dis. Child.)*, 1930, 23, 77-84.
6. FLAGSTAD, A. E., ZANGER, E., and LEVEN, L. Blood chemistry in osteogenesis imperfecta; preliminary report. *Minnesota Med.*, 1924, 7, 800-804.
7. FOOTE, J. A. Clinical Pediatrics, Diseases of the Bones, Joints, Muscles and Tendons, Vol. VII. D. Appleton and Co., New York, 1927.
8. GORTER. Quoted by Fairbank, ref. 5.
9. GRIFFITH, J. P. C., and MITCHELL, A. E. The Diseases of Infants and Children. W. B. Saunders Co., Philadelphia, 1927.
10. HEISE, A. On the identity of imperfect congenital osteogenesis and idiopathic osteopsathyrosis, and on the diagnosis of the latter from infantile scurvy. *Acta radiol.*, 1932, 13, 319-328.
11. KNAGGS, R. L. Osteogenesis imperfecta. *Brit. J. Surg.*, 1923-1924, 11, 737-759.
12. LE MEE. Quoted by Prussak and Mesz, ref. 16.
13. LOBSTEIN, I. Traité d'anatomie pathologique. T. II. Paris, 1833. Quoted by Prussak and Mesz, ref. 16.
14. MAXWELL, J. P., HU, C. H., and TURNBULL, H. M. Foetal rickets. *J. Path. & Bacteriol.*, 1932, 35, 419-440.
15. McLEAN, S. The correlation of the roentgenographic and pathological aspects of congenital osseous syphilis, with particular reference to the first months of life. *Am. J. Dis. Child.*, 1931, 41, 363-395.
16. PRUSSAK, L., and MESZ, N. Ueber die idiopathische Osteopsathyrose. *Acta radiol.*, 1930, 11, 175-193.
17. RYAN, W. J. Osteogenesis imperfecta. *J. Bone & Joint Surg.*, 1932, 14, 939-942.
18. SCHMIDT, M. Quoted by Heise, ref. 10.
19. WAGONER, G. W. Idiopathic osteopsathyrosis (fragilitas ossium). *Ann. Surg.*, 1924, 80, 115-123.

20. WEBER, M. Osteogenesis imperfecta congenita. *Arch. Path.*, 1930, 9, 984-1006.
21. WYATT, T. C., and McEACHERN, T. M. Con-

genital bone dysplasia (osteogenesis imperfecta) associated with lesions of the parathyroid glands. *Am. J. Dis. Child.*, 1932, 43, 403-415.

DISCUSSION

DR. A. H. PIRIE, Montreal, Quebec. The slide that Dr. Bromer showed seemed to me like a mixture of marble bones and osteogenesis imperfecta. I would like to have more information before expressing an opinion on that. Was that child under long continued treatment when the picture was taken?

• DR. BROMER: No, he is just five months old, and is a miserable specimen. He is all deformed.

DR. PIRIE: Were the parents closely related?

DR. BROMER: I can't answer that.

DR. PIRIE: Was the phosphorus increased in the blood?

DR. BROMER: No, normal.

DR. PIRIE: I think I would like to call it "Bromer's disease."

DR. P. F. MORSE, Detroit, Mich. We have been very much interested in this question of the relationship of osteogenesis imperfecta to parathyroidism. We had a very typical case within the past year of osteogenesis imperfecta, but which, as I remember, had a completely normal laboratory bill of health. Because of the large number of pathological fractures we felt justified in operating, and Dr. Ballin can tell you the results of that procedure in this particular case. I am not familiar with the clinical details. On theoretical grounds I do not consider osteogenesis imperfecta to have a relation to parathyroidism, but to represent a congenital familial mesoblastic defect. The defect is in the

stroma and groundwork of the bone and not in the calcium or phosphorous metabolism.

DR. MAX BALLIN, Detroit, Mich. I was much interested in the Doctor's remarks in which he stated that you do not have to take out the parathyroid but by interference with cervical ganglia the same thing can be accomplished. One French author has gone still further and claims any surgical interference around the thyroid region will benefit such cases. The question arises now whether these surgeons who prefer to do a ganglionectomy or just mutilate some tissue around the thyroid in reality interfere with the parathyroid, or whether the parathyroidectomy interferes with the cervical ganglia.

I am very doubtful about this, at least in a few cases, myself. For instance, in the case that Dr. Morse mentioned we did not find any traces of parathyroid, but removed a large thymus remnant from the parathyroid region. In spite of this the orthopedic surgeon in charge of the case tells me that after this operation the many fractures unite now and deformities resulting from the non-union can yield to orthopedic treatment.

This is a conference to discuss the extent of parathyroidism. The pendulum may swing too far and entities may have been taken in not belonging there, but only actual experience and exchange of well-founded opinions will set us right.



THE RELATION OF THE THYROID, THE ADRENALS AND THE ISLANDS OF LANGERHANS TO MALACIC DISEASES OF BONE*

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THYROID

I. Hyperthyroidism.

THE association of hyperthyroidism with a decalcifying disease of bone was first reported by Köppen in 1892. Von Recklinghausen, who performed the necropsy, made a diagnosis of osteomalacia. Köppen thought the decalcification was produced by a vasomotor disturbance in the bone and was not the same as ordinary osteomalacia.

Of a total of 150 cases of osteomalacia, Latzko (1901) found 6 in which hyperthyroidism was present. He believed the thyroid dysfunction affected the bones through the intermediary of the ovaries.

Hoennicke (1904) attributed the decalcification observed in thyrotoxicosis to a disturbance in phosphorus metabolism. He pointed out what he believed to be the similar geographical distribution of goiter and osteomalacia. This was denied by Bossi (1907) who stated that in the region in Italy where there is much osteomalacia there is no goiter. He saw 37 cases of osteomalacia without goiter and many goiters in pregnant women without osteomalacia.

Tolot and Sarvonat (1906) reported a case of hyperthyroidism and osteomalacia. They had found 11 observations in the literature on the relation of these two conditions but were unwilling to accept the thyroid disturbance as the cause of the bone disease.

Von Jaksch and Rotky (1908) attributed the decalcification, softening and bending of the bones of a twenty-year-old girl to long-continued hyperthyroidism but did not believe it was true osteomalacia. Bern-

hardt (1927), recording a similar case, stated his belief that osteomalacia is a pluriglandular affair in which one or another gland may be primarily involved.

Curschmann (1919) reported 30 cases of non-puerperal osteomalacia, some of which were associated with hyper- and some with hypothyroidism. Basal metabolism is not mentioned.

Pause (Cristofolletti, 1911) produced bone changes resembling osteomalacia in pregnant rabbits by removing the thyroid, and recommended thyroid extract in the treatment of osteomalacia. Stettner (1931), on the other hand, reported marked decalcification of the bones of a child resulting from long-continued administration of thyroid extract, with clinical improvement when the extract was discontinued.

Kolodny (1924) found no evidence of healing forty-two days after a fracture in thyroidectomized dogs. Baetzner (1930) and Baumann (1931) reported that the administration of thyroid extract speeded up the healing of fractures in cases where callus formation was slow or incomplete.

Blood calcium studies in hyperthyroidism, as reported in the literature, have given conflicting results which are probably to be attributed to faulty chemical technique. The serum calcium was found by Leicher (1922) to be below normal in hyperthyroidism and after the administration of thyroid extract, by Herzfeld and Neuburger (1924) to be both above and below normal in 19 cases of hyperthyroidism, and by Waldorp and Trelles (1925) to be low in 26 individuals with the same disease.

Aub, Bauer, Heath and Ropes (1929) established the fact that the blood calcium

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and phosphorus are normal in hyperthyroidism. They showed, however, that this condition is associated with an increase in calcium excretion which is out of proportion to the elevation of the basal metabolism. Likewise the ingestion of thyroid extract by normal individuals caused an increased output of calcium. The mechanism of this increased elimination of calcium is unknown (Aub et al.; Albright, Bauer and Aub).

The effect of excessive thyroid secretion on the bones of young persons is ordinarily described in books on roentgenology as an acceleration of growth and of closure of epiphyses.

Aub et al., Plummer, and Dunlap and Moore, reported cases of hyperthyroidism in which decalcification of bones was shown on roentgen examination. It is probably present in many cases but becomes marked only when the disease is of long standing (Plummer). In mild cases it can be detected only by direct comparison with the same bone of a normal individual exposed on the same film at the same time (Aub et al.). It may involve all bones but when slight is most readily observed in the spongy portions; it may be so marked as to suggest malignant metastases (Dunlap and Moore). Osteomalacic changes should be looked for in the bones of adults with hyperthyroidism (Schittenhelm).

We have examined the roentgenograms of 110 cases of hyperthyroidism in an attempt to determine how frequently decalcification of the bones sufficient to be of diagnostic importance might be encountered in an unselected series. In 63 instances only chest films were available; in the remainder, portions of the spine, pelvis or extremities were at hand. It is obviously impossible to make anything like an accurate estimation of the calcium content of the bones as compared with the probable normal at any given age and to determine the presence of slight degrees of decalcification without some such procedure as recommended by Aub et al. Even without direct comparison with the normal, it is

quite possible that more evidence of decalcification might have been disclosed by films of bones other than those available. It is also likely that other observers would disagree with our judgment in certain cases. It seemed worth while, however, to attempt a judgment based on experience, labeling the cases as showing no, slight, definite, or marked decalcification. Dunlap and Moore detected marked thyrotoxic decalcification on the chest films in one case.

Of the 110 cases, the available films showed what we considered to be not definitely abnormal bone density in 86 (78 per cent), slight decalcification in 12, definite in 9 and marked in 3.

The age of the patients ranged from sixteen to sixty-eight years; 28, or approximately 25 per cent, were fifty or over. Of the 24 cases showing bone density which we considered to be below normal, 17 were over fifty; the 3 in which the decalcification was marked were all over fifty.

The duration of the symptoms of thyrotoxicosis as recorded in the histories varied from two months to twenty-six years. It was more than two years in 22 and more than five years in 6. The duration of the disease in the 3 "marked" cases was five months, one year and two and one-half years (one of them had a basal metabolism of +95 per cent). In only 8 of the 24 cases showing some degree of decalcification was the duration of the symptoms more than two years.

In 9 unselected cases a direct comparison was made of the density of the bones of the hand with those of a normal of the same sex and approximately the same age taken with the same exposure on the same films as recommended by Aub et al. These patients were from twenty-two to fifty years old. The duration of the disease was from four months to four years; in 5 instances it was not over six months. Of the 9 cases thus compared, 5 showed evidence of definite and one of slight decalcification; the other 3 were normal.

The low incidence of decalcification in

the large series described above is probably incorrect but the study indicates that it is not sufficiently marked to be of differential diagnostic importance in the vast majority of cases. We have been unable to find a report of a case of thyrotoxicosis with decalcification of the bones in which a return to normal bone intensity followed relief of the hyperthyroidism.

Conclusion

Hyperthyroidism produces an abnormal elimination of calcium, the mechanism of which is not understood. It seems to be frequently associated with a decalcification of the bones demonstrable on the roentgenogram by suitable comparison with the normal, which is so slight as to be of little if any importance. In rare cases the decalcification of the bones may be extreme. Its appearance, however, is not characteristic of thyrotoxicosis.

II. Hypothyroidism.

The growth-limiting effect of lack of thyroid secretion in the young such as in cretinism or infantile myxedema is well known (Barker, Köhler, Engelbach and McMahon). We have found no mention of bone density in hypothyroidism (Barker, Köhler, Falta, Baetjer and Waters, Emerson, Käding) except by Janney who says, referring to cretins, "Often the bones are apparently normal roentgenologically (except for disturbances in development). . . . The long bone shafts may be the seat of osteoporotic and sclerotic changes, the marrow cavity is usually small." Myxedema in adults produces no demonstrable roentgen changes in bones (Schittenhelm).

Leicher states that the blood calcium is above normal in myxedema. Aub et al. found calcium excretion markedly diminished in hypothyroidism.

We have examined the available films of 51 cases labeled hypothyroidism or myxedema in the files of the Presbyterian Hospital, New York, ranging in age from seventeen to eighty years. Cases in which a polyglandular syndrome seemed to be present

were discarded. The assortment of films was about the same as in the hyperthyroid cases. The difficulties of the estimation of bone densities have already been discussed.

Of the 51 cases, 37 showed none, 9 slight, 3 definite and 2 marked decalcification. The last two were aged sixty-six and eighty years; the 3 showing definite decalcification were aged fifty-four, fifty-seven and sixty-three years. Many over fifty and even over seventy showed bones of apparently normal density. We doubt, therefore, that the thyroid condition had anything to do with the density of the bones in these cases.

We also examined the films of 20 cases labeled infantile myxedema or cretinism, ranging in age from four months to twelve years. In all but one, the films included one or more extremities. In only one case, recorded as "hypothyroid dwarfism" was there definite decalcification. The long bones of all the cretins showed a widening of the cortex in relation to the width of the shaft as compared with non-cretins of the same chronological age. A circle of increased density around the margins of the carpal centers of ossification and thickening of the zones of preparatory calcification were occasionally noted. The well-known disturbance and delay in epiphyseal and ossification center development needs no comment.

Conclusion

In cretinism and infantile myxedema there is a widening of the cortex of the long bones without loss of calcium.

Hypothyroidism in adults is apparently associated with no greater incidence of decalcification of bones than that which might be encountered in any group of patients of the same age.

ADRENALS

Attention was first directed toward a possible relation between the adrenals and the bones by Bossi in 1907. He removed one adrenal gland in 3 sheep and found by histological examination of the bones that

osteomalacia developed. He treated osteomalacia by the injection of adrenalin on the theory that it would contract the blood vessels in the bone and relieve pain. The results were very satisfactory. This evidence indicated to him that osteomalacia is caused by an insufficiency of the adrenals. His case reports are interesting but his experimental work is unconvincing. Biedl, Cristofolletti, Solda, and Erdheim were unable to confirm Bossi's results following extirpation of the adrenals in animals (Scipiades).

Cristofolletti (1911) removed both adrenals from 60 rabbits and a number of white rats. Some of the animals lived longer than four weeks. None showed evidence of bone disease. Novak found no skeletal changes after adrenal extirpation (Kosdoba).

No bone changes resembling osteomalacia have been described in the literature at our disposal in either Addison's disease or virilism. Chabrol and Haguénau (1923) reported a necropsied case of osteomalacia of twenty-five years' duration with very large (30 gm.) adrenals. Erdheim found no adrenal disease at necropsy in cases of osteomalacia (Scipiades).

Bauer (1912) relieved the pain of osteomalacia by injections of adrenalin but did not consider the adrenals to be the cause of the disease. Assmann records the temporary relief of pain by the same medication in a similar case, later cured by castration. Varaldo attributed the favorable effect of adrenalin injections in this disease to a damage to the over-functioning ovaries (Scipiades). Bernard (1931) claims that he cured a case of osteomalacia by subcutaneous injections of adrenalin continued over a considerable period of time. Curschmann (1919) believed that the adrenals have nothing to do with the disease.

Cristofolletti states that adrenalin injections caused the calcium output to increase and cannot be recommended as a treatment for osteomalacia although in some cases they have a favorable effect on the symptoms. He thinks that the ovaries have a depressing effect on the chro-

maffin system especially in pregnancy and that osteomalacia is caused by an endocrine imbalance. Bauer (1921) remarks that injections of adrenalin caused an increased calcium output.

The removal of both adrenals in animals is followed by a slight rise in the serum calcium (Swingle, 1926), by a decided rise three to five hours after the operation (Taylor and Caven, 1927), by a rise simultaneous with or slightly in advance of symptoms of adrenal insufficiency (Rogoff and Stewart, 1928).

Of 3 cases of Addison's disease at the Presbyterian Hospital (Loeb) the serum calcium was normal in 2 and definitely increased in one, two days before death.

The injection of alcoholic extracts of suprarenal cortex, according to Mirvish and Bosman, temporarily lowered the blood calcium in the majority of 50 rabbits. They believe this hormone to be antagonistic to that of the parathyroids.

The conflicting opinions in the literature regarding the relation between the adrenals and osteomalacia, calcium metabolism and bone regeneration, and the effect of adrenalin injections are well summarized by Kosdoba (1932) and will not be further recapitulated here. Calcium metabolism is under so many and variegated influences that it is difficult to appraise the effect of any one. For example, in 3 normal young men, subjects for studies of normal electrolyte balances, Loeb found a shift to a negative calcium balance in the course of three to five weeks on a regimen which required the subjects to be in bed all the time except for four hours a day. The same results were obtained in 2 diabetics under the same regimen. It is evident that simple rest in bed is sufficient to throw a normal person into a negative calcium balance.

We have examined the available roentgenograms of 14 cases of Addison's disease, ranging from seventeen to seventy-four years of age. Three showed questionable slight decalcification and one a marked diminution in density of the bones of the

hands. These 4 patients were all over fifty years old.

Two cases of adrenal tumor, aged three years, showed in one instance slight and the other definite decalcification with a peculiar coarsening of trabeculation.

Conclusion

Although adrenal secretion either directly or indirectly influences calcium metabolism, and although the adrenals may be indirectly involved in a pluriglandular imbalance in certain cases of osteomalacia, the evidence does not seem to justify the assumption that decalcification of the bones results directly from adrenal disease or dysfunction.

ISLANDS OF LANGERHANS

Considerable evidence has been presented in the literature that a loss of calcium from the body takes place in diabetes. Von Noorden quotes Bocker as having demonstrated in 1853 an increased excretion of calcium in the urine of diabetic patients as compared with normal persons. Neubauer, and Toralbo later made similar observations. Von Noorden found that a diabetic patient excreted more calcium in both urine and feces than he took with his food.

Gerhardt and Schlesinger (1899) stated that the output of calcium in the urine is especially high in acidosis, runs parallel with the ammonia excretion and is reduced by the administration of alkali. Dengler found that the calcium loss could be stopped by giving calcium but not sodium (von Noorden). Sawyer, Baumann and Stevens (1918) disclosed a negative calcium balance in a child with marked acidosis and a normal balance in another with less acidosis. Von Noorden states that the calcium metabolism is the same in diabetics in the absence of acidosis as in normal persons. Kahn and Kahn (1916), however, found a negative calcium balance in 5 cases of mild diabetes without acidosis. Kahn and Hoffmann (1915) found a daily calcium loss in diabetes which was much reduced when

the glycosuria stopped; the administration of calcium chloride changed the calcium balance from negative to positive. Wishnofsky (1927) concludes that a negative calcium balance has been established in diabetes.

Falta and Whitney (1908) found that pancreatectomy in dogs was followed by an immediate and rapid elimination of calcium. Meyer-Bisch (1927) demonstrated a decrease in blood calcium of 1.2 to 2.0 mg. per 100 c.c. in 12 of 16 pancreatectomized dogs. Kolodny (1924) reported a marked slowing up of callus formation in incompletely pancreatectomized dogs.

Opinions on the blood calcium level in diabetes and the effect of insulin on it differ. Harrop and Benedict (1924) showed the blood calcium to be normal in diabetics with severe acidosis and to be unaffected by the administration of insulin. Davies, Dickens and Dodds (1926) found the blood calcium increased in rabbits after the injection of insulin. Brougher (1927) reported an increase in blood calcium for two and a half hours after the injection of insulin. Kylin (1927) states that the blood calcium is higher than normal in diabetics and that the injection of insulin lowers it and causes an increased output of calcium in the urine.

These discrepancies may well be due to the difficulties inherent in the technique of calcium determinations. One must accept the work of those whom he knows to be accurate and careful chemists.

There is some evidence that decalcification of the bones may occur in diabetes. Ferrier refers to some work by Tessier (1876) and Charrin (1905) in which skeletal decalcification in animals was produced by giving lactic acid. Stettner (1931) states that acidosis may cause osteoporosis. Udaondo (1919) described a marked increase in the fragility of the bones in 2 diabetics who had the disease a long time. The fractures were very slow in healing. The injection of sugar into rabbits for from one to three months resulted in a softening and transparency of the bone

and spontaneous fractures occurred. This he attributed to hyperglycemia.

Morrison and Bogan (1927) found that bone atrophy occurs in a certain number of children who develop diabetes before the ninth year but not after that age. Narrowness of the shaft and thinness of the cortex were noted in the bones of children with long-standing diabetes.

A much emaciated boy of ten years of age, who came to the Presbyterian Hospital in 1922 with severe diabetes and acidosis, had marked decalcification of the bones of a character such as to suggest osteomalacia. There was also marked irregularity and delay in the development of the centers of ossification in the epiphyses and carpal bones. He was among the first patients to receive insulin and improved greatly. Four years later the bones of the lower extremities appeared normally dense on the roentgenograms. Films of the bones of 10 other diabetic children showed definite decalcification in only 2 and these were undernourished.

Examination of the available films of 60 adult diabetics disclosed definite decalcification in 9 and slight in 6, of whom 4 were over seventy years of age, 6 over sixty, 3 over fifty and 2 others forty-nine and thirty-eight. Many of these patients had one or more complicating conditions such as arthritis, arteriosclerosis, cardiac disease, etc., which made it difficult to attribute the bone condition to diabetes. Of the 15 show-

ing diminished bone density, acidosis was present in only one instance. One youth of fourteen had diabetes of two years' duration with considerable acidosis and definite decalcification.

Conclusion

Calcium metabolism is intimately linked up with carbohydrate metabolism. The available evidence indicates that a calcium loss may take place in diabetes, especially with acidosis, although not in every case. In children the disease may be associated with a decrease in bone density on the roentgenogram, which in one case was so marked as to suggest osteomalacia. The question may be raised as to how much of this is of endocrine and how much of nutritional origin. Roentgen evidence of definite important skeletal decalcification in diabetic adults which can be attributed directly to the disease is lacking.

SUMMARY

The evidence at hand indicates that skeletal decalcification of a degree sufficient to be of differential diagnostic importance on the roentgenogram and attributable to the endocrine disturbance may be encountered in hyperthyroidism but not in hypothyroidism, in disease of the adrenals nor in adult diabetics. In diabetic children decalcification of the bones is occasionally found, for which acidosis or malnutrition or both together are probably responsible.

REFERENCES

1. ALBRIGHT, F., BAUER, W., and AUB, J. C. Studies of calcium and phosphorus metabolism; influence of thyroid gland and parathyroid hormone upon total acid-base metabolism. *J. Clin. Investigation*, 1931, 10, 187-219.
2. ASSMANN, H. Die klinische Röntgendiagnostik der inneren Erkrankungen. Fourth edition. F. W. C. Vogel, Leipzig, 1929, p. 969.
3. AUB, J. C., BAUER, W., HEATH, C., and ROPES, M. Studies of calcium and phosphorus metabolism. III. The effects of the thyroid hormone and thyroid disease. *J. Clin. Investigation*, 1929, 7, 97-137.
4. BAETJER, F. H., and WATERS, C. A. Injuries and Diseases of the Bones and Joints. P. B. Hoeber, New York, 1921.
5. BAETZNER, W. Vorläufige Mitteilung. [Schilddrüsenpräparate und Knochenbildung.] *Zentralbl. f. Chir.*, 1930, 57, 2906.
6. BARKER, L. F. Endocrinology and Metabolism. Appleton and Co., New York, 1922.
7. BARKER, L. F. The classical endocrine syndromes. *N. York M. J.*, 1921, 113, 353. Abs. in Tice, *Internat. Med. Digest*, 1921, 2, 757.
8. BAUER, J. Kalkstoffwechsel und innere Sekretion. *Wien. klin. Wchnschr.*, 1921, 34, 314.
9. BAUER, J. Zur Klinik der Tetanie und Osteomalazie. Ein Beitrag zur Pathogenese der kal-

- zipriven Osteopathien. *Wien. klin. Wchschr.*, 1912, 25, 1780-1787.
10. BAUMANN, E. Die Anregung der Knochenneubildung durch Schilddrüsenpräparate. *Zentralbl. f. Chir.*, 1931, 58, 655-657.
 11. BERMAN, LOUIS. The endocrine treatment of Paget's disease. *Endocrinology*, 1932, 16, 109-119.
 12. BERNARD, L. Osteomalacie. *Tr. méd. Brouardel*, 1912, 39. Les ostéopathies myélogènes. *Rev. de méd.*, 1909. Also: *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1931, 55, 1213.
 13. BERNHARDT, H. Ein Beitrag zur nichtpuerperalen Osteomalazie. *Deutsche med. Wchschr.*, 1927, 53, 1082.
 14. BIEDL. Quoted by Scipiadès, ref. 59.
 15. BOCKER. Quoted by von Noorden, ref. 68.
 16. BOSSI, M. L. Die Nebennieren und die Osteomalacie. *Arch. f. Gynäk.*, 1907, 83, 505.
 17. BROUGHER, JOHN C. Blood calcium as affected by insulin. *Am. J. Physiol.*, 1927, 80, 411-415.
 18. CHABROL, E., and HAGUENAU. Un cas d'ostéomalacie masculine; étude des glandes à sécrétion interne. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1923, 47, 973-977.
 19. CHARRIN. Quoted by Ferrier, ref. 30.
 20. CRISTOFOLETTI, R. Zur Pathogenese der Osteomalazie. *Gynaek. Rundschau*, 1911, 5, 113; 169.
 21. CURSCHMANN, H. Ueber den mono- und pluriglandulären Symptomenkomplex der nichtpuerperalen Osteomalacie. *Deutsches Arch. f. klin. Med.*, 1919, 129, 93.
 22. DAVIES, D. T., DICKENS, F., and DODDS, E. C. Observations on the preparation, properties and source of the parathyroid hormone. *Biochem. J.*, 1926, 20, 695-702.
 23. DENGLER. Quoted by von Noorden, ref. 68.
 24. DUNLAP, H. F., and MOORE, A. B. Osteoporosis secondary to hyperthyroidism. *Med. Clin. N. Am.*, 1929, 12, 1511-1519.
 25. EMERSON, C. P. Abt's Pediatrics. W. B. Saunders Co., Philadelphia, 1923-1926. Congenital and Infantile Myxedema. Vol. 4, p. 805; Cretinism. Vol. 4, p. 816.
 26. ENGELBACH, WM., and McMAHON, ALPHONSE. Osseous development in endocrine disorders. *Radiology*, 1924, 2, 378-410.
 27. ERDHEIM. Quoted by Scipiadès, ref. 59.
 28. FALTA, WILHELM. Endocrine Diseases. Edited and translated by Sir Archibald E. Garrod. P. Blakiston's Son and Co. Third edition. Philadelphia, 1923.
 29. FALTA, W., and WHITNEY, J. L. Zur Kenntnis des Eiweiss- und Mineralsstoffwechsels pankreasdiabetischer Hunde. *Beitr. z. chem. Phys. u. Path.*, 1908, 11, 224-228. Quoted by Wishnofsky, ref. 70.
 30. FERRIER, P. Malades physiologiques. *Bull. Acad. de méd.*, 1928, 99, 283-289.
 31. FOERSTER, A. Zur Frage der nichtpuerperalen Osteomalazie. *Wurzb. Abhandl. a. d. Gesamtgeb. d. Med.*, 1925, 22, 243-253.
 32. GERHARDT, D., and SCHLESINGER, W. Ueber die Kalk- und Magnesiumausscheidung beim Diag. Mell. und ihre Beziehung zur Ausscheidung abnormer Säuren (Acidose). *Arch. f. exper. Path. u. Pharmacol.*, 1899, 42, 83.
 33. GOLDNER, J. Thyroid function during consolidation of fractures. *Compt. rend. Soc. de biol.*, 1925, 92, 725-727. Abs. *J. Am. M. Ass.*, 1925, 84, 1532.
 34. HARROP, G. A. JR., and BENEDICT, E. M. The participation of inorganic substances in carbohydrate metabolism. *J. Biol. Chem.*, 1924, 59, 683-697.
 35. HERZFELD, E., and NEUBURGER, J. Hyperthyroidism and blood calcium. *Deutsche med. Wchschr.*, 1924, 50, 1324-1325. Abs. *J. Am. M. Ass.*, 1924, 83, 1465.
 36. HOENNICKE, E. Zur Theorie der Osteomalacie; zugleich zur Lehre von den Krankheiten der Schilddrüse. *Berl. klin. Wchschr.*, 1904, 41, 1154.
 37. JANNEY, N. W. Endocrinology and Metabolism. Edited by L. F. Barker. Appleton and Co., New York, 1922, Vol. I, p. 391.
 38. KÄDING, K. Endokrine Störungen und Röntgendiagnostik. *München. med. Wchschr.*, 1927, 74, 747-751.
 39. KAHN, M., and HOFFMANN, J. Calcium metabolism in normal and diabetic individuals. *Biochem. Bull.*, 1915, 4, 213.
 40. KAHN, M., and KAHN, M. H. Lime deficiency of diabetes mellitus. *Arch. Int. Med.*, 1916, 18, 212.
 41. KÖHLER, A. Röntgenology. English translation by Arthur Turnbull. Wm. Wood and Co., New York, 1927.
 42. KOLODNY, A. Endocrine disturbances and nonunion of fractures; experimental study. *Surg., Gynec. & Obst.*, 1924, 38, 793-797.
 43. KÖPPEN. Ueber Knochenkrankungen bei Morbus Basedowii. *Neurol. Centralbl.*, 1892, 11, 219.
 44. KOSDOBA, A. S. Experimentelle Untersuchungen über die Heilung von Knochenbrüchen bei Nebennierenhyperfunktion. *Arch. f. klin. Chir.*, 1932, 169, 96-106.
 45. KYLIN, E. Ueber den Kalkumsatz bei Diabetes mellitus. *Acta med. Scandinav.*, 1927, 66, 197-206.
 46. LATZKO. *Jahrb. d. Psychiat. u. Neurol.*, 1901, 20, 410.
 47. LEICHER, H. Action of endocrines on serum calcium. *Deutsches Arch. f. klin. Med.*, 1922, 141, 85-116. Abs. *J. Am. M. Ass.*, 1923, 80, 882.
 48. LOEB, ROBERT. F. Personal communication.
 49. MEYER-BISCH, R. Mineral- und Wasserstoff-

- wechsel bei Diabetes mellitus. *Ergebn. d. inn. Med. u. Kinderh.*, 1927, 32, 267-312.
50. MIRVISH, L., and BOSMAN, L. P. The effect of extracts of suprarenal cortex on the blood calcium. *Brit. J. Exper. Biol.*, 1929, 6, 350.
 51. MORRISON, L. B., and BOGAN, I. K. Bone development in diabetic children; a roentgen study. *Am. J. M. Sc.*, 1927, 174, 313-319.
 52. NEUBAUER. Quoted by von Noorden, ref. 68.
 53. NOVAK. Quoted by Kosdoba, ref. 44.
 54. PAUSE. Quoted by Cristofolletti, ref. 20.
 55. PLUMMER, W. A. Cases showing osteoporosis due to decalcification in exophthalmic goiter. *Proc. Staff. Meet. Mayo Clinic*, 1928, 3, 119-121.
 56. ROGOFF, J. M., and STEWART, G. N. Studies on adrenal insufficiency. VII. Further blood studies (cholesterol and calcium) in control adrenalectomized dogs. *Am. J. Physiol.*, 1928, 86, 25-31.
 57. SAWYER, M., BAUMANN, L., and STEVENS, F. A. Studies of acid production. II. The mineral loss during acidosis. *J. Biol. Chem.*, 1918, 33, 103.
 58. SCHITTENHELM, A. *Lehrbuch der Röntgendiagnostik*. Springer, Berlin, 1924, p. 1170.
 59. SCIPIADES, E. Ueber Osteomalacie. *Ztschr. f. Geburtsh. u. Gynäk.*, 1919, 81, 156-226.
 60. STETTNER, E. Ossificationstudien am Handskelet des Kindes. IV. Pathologisches Osteoporoseformen. Hyperthyreoide Osteoporose. Die jahreszeitliche Schwankung der Osteoporose. Der "Winterschaden." Chronische Osteoporosezustände. *Ztschr. f. Kinderh.*, 1931, 52, 14-23.
 61. SWINGLE, W. W. Studies on the functional significance of the suprarenal cortex. I. Blood changes following bilateral epinephrectomy in cats. *Am. J. Physiol.*, 1927, 79, 666-678.
 62. TAYLOR, N. B., and CAVEN, W. R. Observations upon the serum calcium after adrenalectomy. *Am. J. Physiol.*, 1927, 81, 511.
 63. TESSIER, J. Quoted by Ferrier, ref. 30.
 64. TOLOT, G., and SARVONAT, F. Ostéomalacie et goitre exophthalmique. *Rev. de méd.*, 1906, 26, 445-455.
 65. TORALBO. Quoted by von Noorden, ref. 68.
 66. VARALDO. Quoted by Scipiadès, ref. 59.
 67. VON JAKSCH, R., and ROTKY, H. Ueber eigenartige Knochenveränderungen in Verlaufe des Morbus Basedowii. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1908-1909, 13, 1-21.
 68. VON NOORDEN, C. *Metabolism and Practical Medicine*. W. T. Keener and Co., Chicago, 1907, Vol. III, p. 600.
 69. WALDORP, C. P., and TRELLES, R. A. Calcémie et glycémie dans les maladies de la thyroïde avec augmentation du métabolisme basal. *Rev. Soc. argent. de biol.*, 1925, 1, 762-773.
 70. WISHNOFSKY, M. Studies in calcium and carbohydrate metabolism; calcium and glucose tolerance in diabetes mellitus. *J. Lab. & Clin. Med.*, 1927, 13, 133-138.
 71. UDAONDO, C. B. Bone complications of diabetes. *Rev. de la Asoc. méd. argent.*, 1919, 30, 285. *Abs. J. Am. M. Ass.*, 1919, 73, 1733.



SCHÜLLER-CHRISTIAN'S DISEASE*

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SCHÜLLER-CHRISTIAN'S disease or Christian's syndrome of defects in membranous bones, exophthalmos and diabetes insipidus, a special form of essential xanthomatosis has attracted considerable attention. There are now records of over 60 cases which closely conform to the syndrome. Recently general reviews have been made by Chiari,¹ Henschen,² Moreau,³

ic studies have been made and there is still much to learn from the roentgen examinations of the bones as to the nature of the change in the skeletal system.

Although the etiology is in doubt, the nature of the disease seems fairly well established and may be suggestive in determining the approach to the pathogenesis of other bone diseases. I am glad to have an

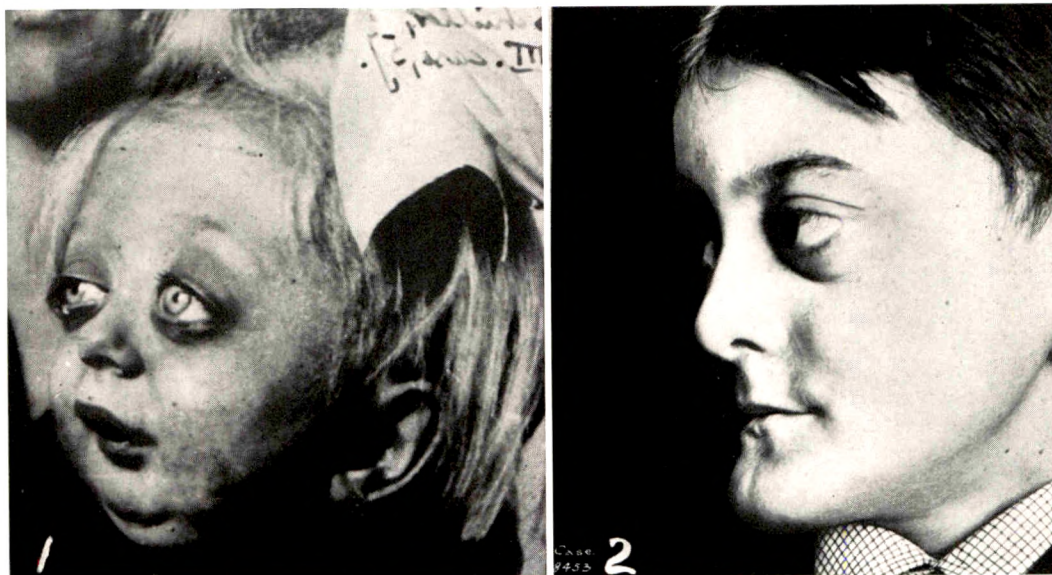


FIG. 1. Patient of Schüller's, aged four; onset at the age of two; exophthalmos, diabetes insipidus, bone defects.

FIG. 2. Patient of Thompson, Keegan and Dunn's, boy aged nine; onset at the age of seven and a half; exophthalmos, diabetes insipidus emaciation; extensive skull defects; "old man" appearance due to destructive bone changes in the maxillae.

Pincherle,⁴ and in my presentation⁵ last year, in textbook form, of lipid metabolism disturbances.

This disease is of interest to the roentgenologist because of the importance of the roentgen ray in diagnosis and treatment. I believe you are familiar with the splendid work of Dr. Sosman on the roentgen treatment of this affection. As it is a relatively new disease, few comparative roentgenolog-

opportunity to discuss some phases of the subject in this symposium on malacic bone affections.

Schüller-Christian's disease is a rare, probably familial, constitutional disorder of metabolism in which a deposition of lipid mixtures, particularly cholesterol and its ester, takes place leading to a characteristic hyperplastic reaction in the reticulo-endothelial or the histiocytic apparatus. The

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

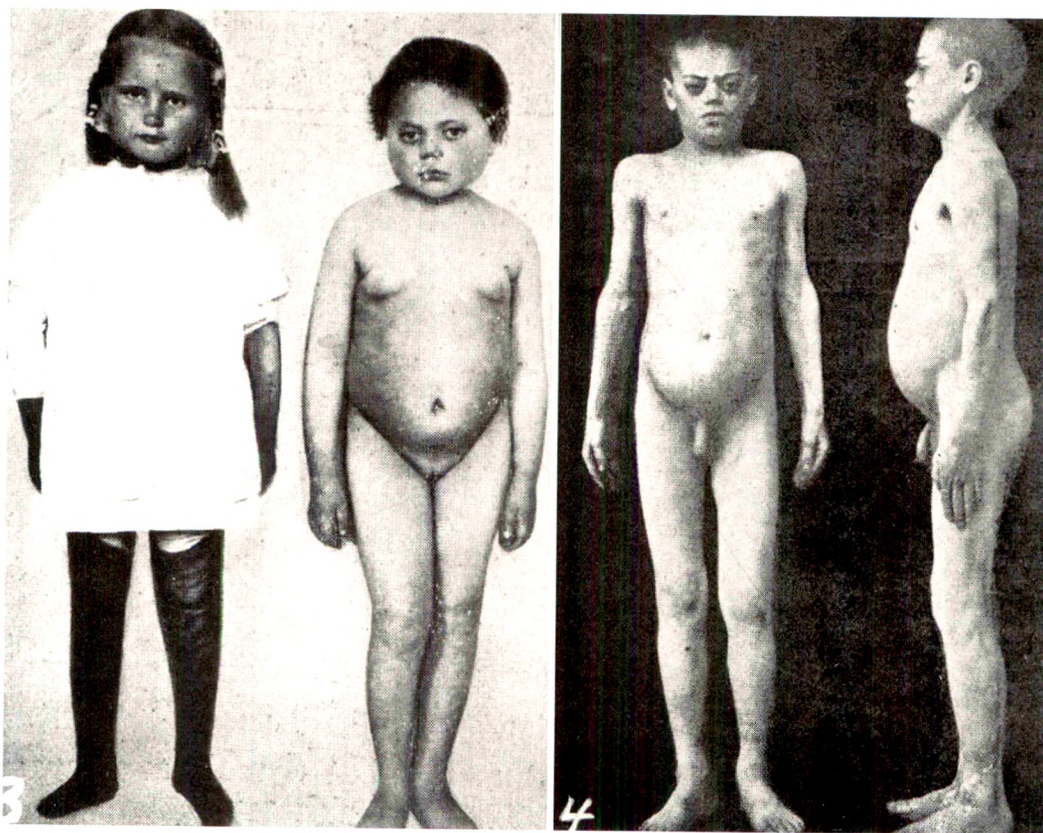


FIG. 3. Patient of Kyrklund's, girl aged twelve; onset with thirst and polyuria at the age of four; retarded growth and mental development. Suddenly became fat at the age of seven, developing the clinical picture of dystrophia adiposogenitalis. At her side a normal child of five.

FIG. 4. Patient of Alberti's, boy aged twenty-one; hypogenitalism and subnormal mentally. Mentality of a boy of thirteen.

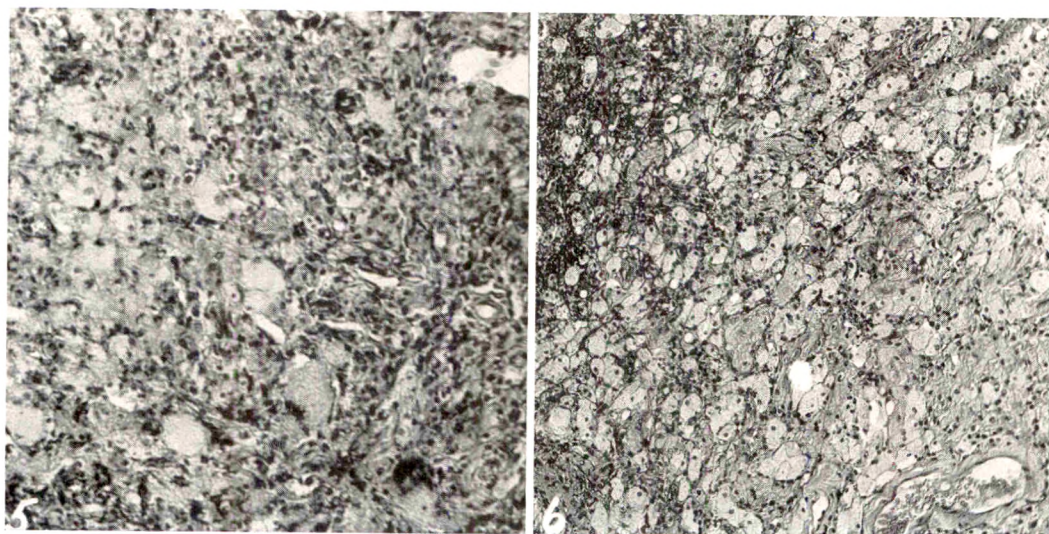


FIG. 5. Dural plaque, many large foam cells, round cells, eosinophile cells, fibrosis, clear spaces, cholesterol clefts.

FIG. 6. Section from lower end of right femur; many foam cells, round cell infiltration.

common pathologic change is a granuloma-like accumulation arising from connective tissue in many parts of the body. Usually three cardinal symptoms—bone defects, exophthalmos and diabetes insipidus—are present but it should be understood that no one of these is essential and that there are others which sometimes appear of equal importance.

The most often observed form of the disease occurs in early childhood but there are also rare adolescent and adult types. As Schüller-Christian's disease is a constitutional affection, symptomatology and pathology vary with different stages of development and with the age period of the patient. In this discussion, I shall draw attention to these variations in a description of the symptomatology and pathology, giving my own interpretation of the changes in the skeletal system.

In the early childhood form of Schüller-Christian's disease, the patient gives a history of good health up to the time of onset. During the second, third or fourth year following one of the common childhood affections (measles, mumps, scarlet fever or pertussis) convalescence is prolonged, there is increased irritability, excessive thirst, ex-

ophthalmos, sore mouth with loose teeth or vague pains referred to various parts of the body. Sometimes there is a limp or abnormal posture. On examination bone defects are found. The disease progresses irregularly. The bone defects increase. There may be periods of unexplained fever, the skin becomes pale, dry and scaly, or a fine papular eruption appears over various parts of the body. Sometimes the spleen, liver and lymph nodes become moderately enlarged. There is an arrest of growth and emaciation. Respiratory symptoms appear; the child becomes cyanotic and dyspneic or very pale and anemic; the heart dilates slightly. Frequently death occurs in from two to four years as a result of respiratory and cardiac complications or severe anemia.

In the occasional more protracted adolescent forms of the disease there are at first very few symptoms. Growth, however, is retarded. The bone defects increase slowly although during remissions they may become smaller and even disappear. The exophthalmos, polyuria and polydipsia sometimes lessen or entirely subside for a period. Occasionally around the seventh or eighth year, the child suddenly grows fat, assuming the appearance of a dystrophia adiposo-

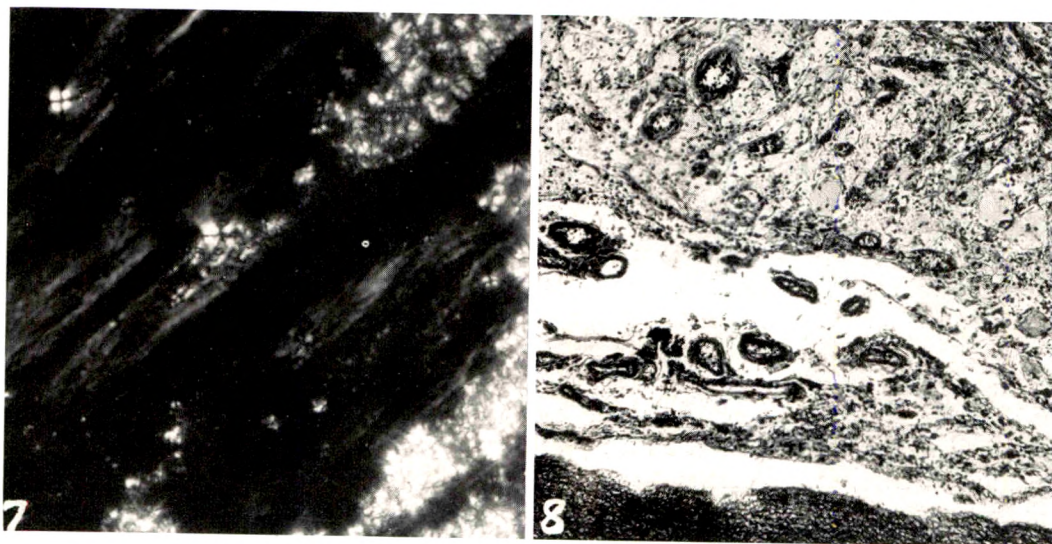


FIG. 7. Dural plaque showing anisotropic fat (cholesterol ester) as it appears in the polarizing microscope.

FIG. 8. Tuber cinereum section showing many foam cells. Characteristic xanthomatous granuloma-like tissue.

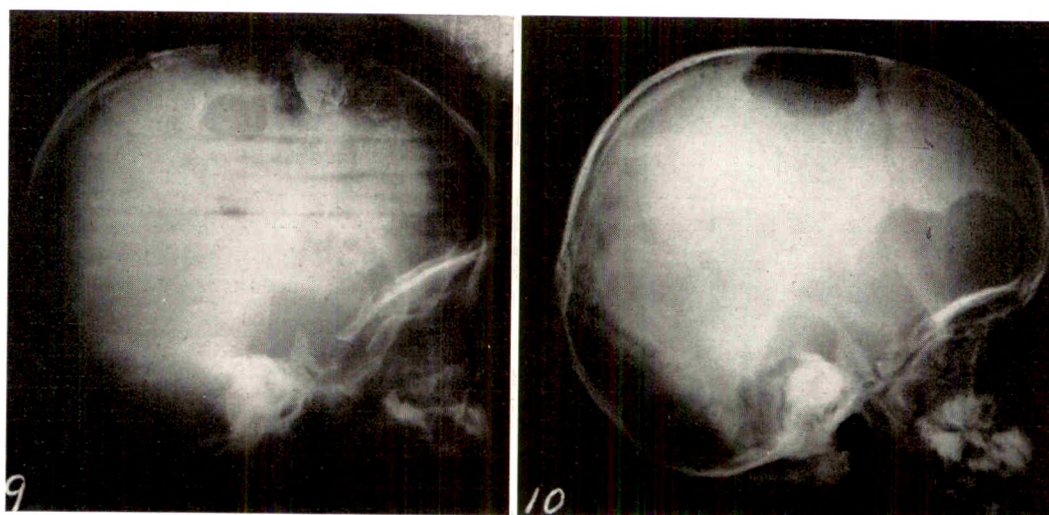


FIG. 9. Showing skull defects in the calvarium and at the base involving the sella turcica.
 FIG. 10. Same patient six months later, showing extensive increase in the destructive process.

genitalis, with signs of mental retardation. Patients with this protracted form live into the second and third decade.

In the still more protracted and rare cases or adult form of the affection, a true polyglandular syndrome may develop. In one case, the hypophyseal cachexia of Simmonds was observed and in others acromegaly with lipemia and glycosuria. In this type, the bone changes vary considerably from those observed in the infantile and adolescent forms.

The remarkable pathology which accounts for most of these symptoms appears first as masses of foam cells, or histiocytes loaded with fat, in the tissues surrounding the small blood vessels; then in the form of granuloma-like accumulations arising from dense connective tissue or as a more diffuse process in many tissues and organs, and finally as a marked fibrosis and foreign body giant cell reaction. These changes intermingle and are only determined by careful study. In the bone pathology they are still further confused by the fact that one cannot entirely separate lesions of the dura and periosteum from bone marrow lesions and by a constant tendency towards healing which confuses the pathologic picture.

The infiltration of foam cells in the bone

marrow is sometimes circumscribed, sometimes diffuse. In many places a small round or eosinophile cell infiltration is well marked, and hemorrhagic areas intermingled with necrosis are frequent. As a consequence of the massive growth of foam cells in the marrow spaces, the bone trabeculae gradually atrophy and degenerate so that the normal bone disappears. In an advanced stage the cortex of the bone is replaced by new-formed spongiosa with here and there osteoid and cartilage-like tissue. In some areas the new tissue appears as a fine spongy layer below the original cortex and in other places, where bone tissue is completely absent, the peripheral fibrous layer reaches directly to the periosteum. The periosteum is usually unchanged but in older adult forms of the disease there may be a building of new bone which generally develops inside the periosteum both in the calvarium and long bones. In the healing process large areas of fibrosis and finally dense osteoid tissue are found.

The bone resorption resembles in many respects that seen in osteomalacia, that is, a demineralization atrophy although it is really a destructive bone process or a pressure atrophy. At autopsy the bone surrounding the defects is frequently found to be soft. In a case which I recently observed,

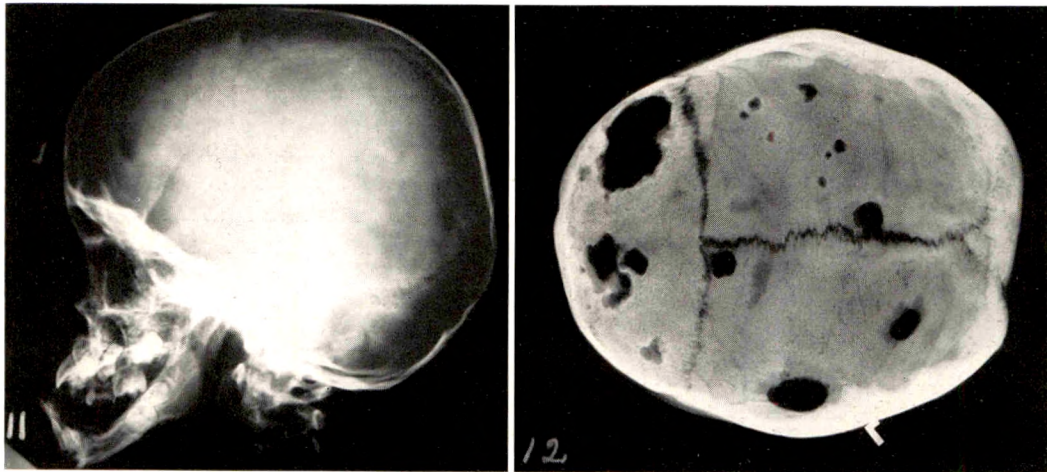


FIG. 11. Same patient as in Figure 9 one year later—almost complete disappearance of bone defects, with formation of dense bone at the base, osteosclerotic healing process.

FIG. 12. Photograph of the calvarium showing characteristic moth-eaten appearance.

the calvarium was soft and pliable and the whole base of the skull cut like cheese. Histologically the bone lesions frequently give a superficial impression of osteitis fibrosa or occasionally, in the more advanced adult form of the disease, of an osteitis deformans.

Changes in the skull are of first importance in this disease. Roentgen examination sometimes reveals extensive bone destruction or defects in the calvarium, and at the base of the skull involving the sella turcica, sinuses, orbit, mastoid and facial bones. One or both tables of the skull may be affected. The destructive change has been compared to the moth-eaten holes in a piece of flannel or, when extensive, to the gulfs and lakes on a map and the roentgen picture has been aptly described as "geographic." The larger bone defects occur in the places where bone marrow and dura or periosteum are affected.

The membranous and flat bones are most often involved but changes may occur in any part of the skeleton. Roentgen examination reveals similar, though less extensive, changes in the superior and inferior maxillae, flat bones of the pelvis, scapulae, ribs, vertebrae and the long and short bones. The defects in these bones have the same irregular moth-eaten appearance and sharp-

ly defined borders. Occasionally, when there is a cyst formation, the borders are less irregular and the defects are round or oval with less sharply defined edges. In an advanced stage of the disease, the edges are sometimes blurred, indicating an attempt at repair. New bone formation can even fill in large defects. The surrounding bone appears to be normal in the roentgenogram as do the bones in other parts of the skeleton. Bone thickening is rare in the acute form of the disease but occurs sometimes in the adult form, usually developing inside the periosteum.

A number of important symptoms result from the bone destruction. Loose teeth frequently occur. The gums become swollen, spongy, and tender, separating from the teeth which, although normal, loosen and fall out. In several cases a viscid yellow discharge from the middle ear occurred and persisted so that eventually a mastoid operation was performed. In healing, the infiltration in the mastoid region may lead to a deposit of dense bone and deafness. The antrums and nasal sinuses are sometimes affected in a similar manner and the marked destruction about the orbits may be a factor in the exophthalmos. Observations indicate, however, that the protrusion of the eyes is the result of the accumulation of

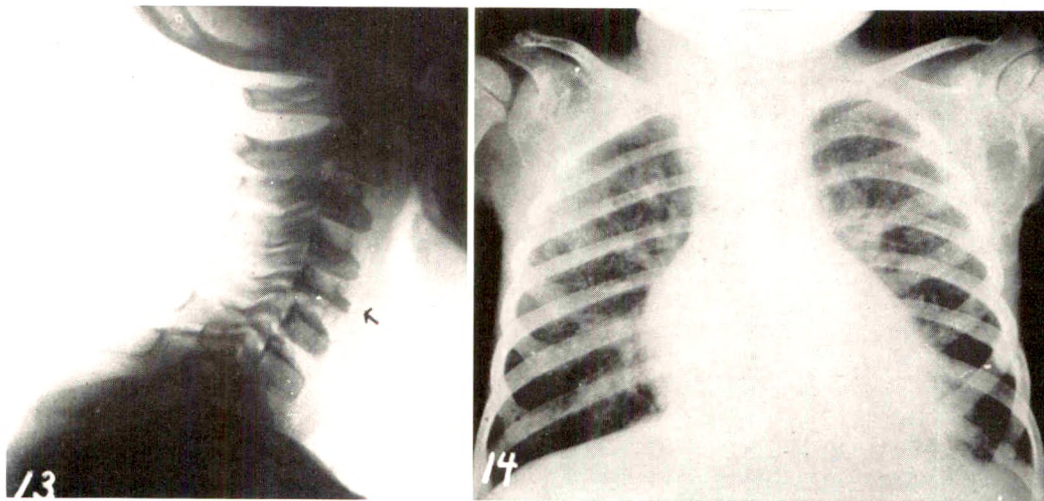


FIG. 13. Compression fracture of vertebral body. Patient had torticollis.

FIG. 14. Osteoporotic bone changes in the scapulae and ribs.

lipid granuloma in the orbits. It has been suggested that the retardation in growth may be due partly to lipidosis in the long bones (Henschen). In a few cases in connection with the bone destruction there has been a spontaneous fracture. When the vertebrae are involved, there is sometimes

a compression fracture of the vertebral body and gibbus or torticollis. The intervertebral discs are never affected. There may be considerable deformity when the pelvic bones are involved. In a recent case of Moreau's there was expansion in the mid-diaphysis of the femur. It is of interest

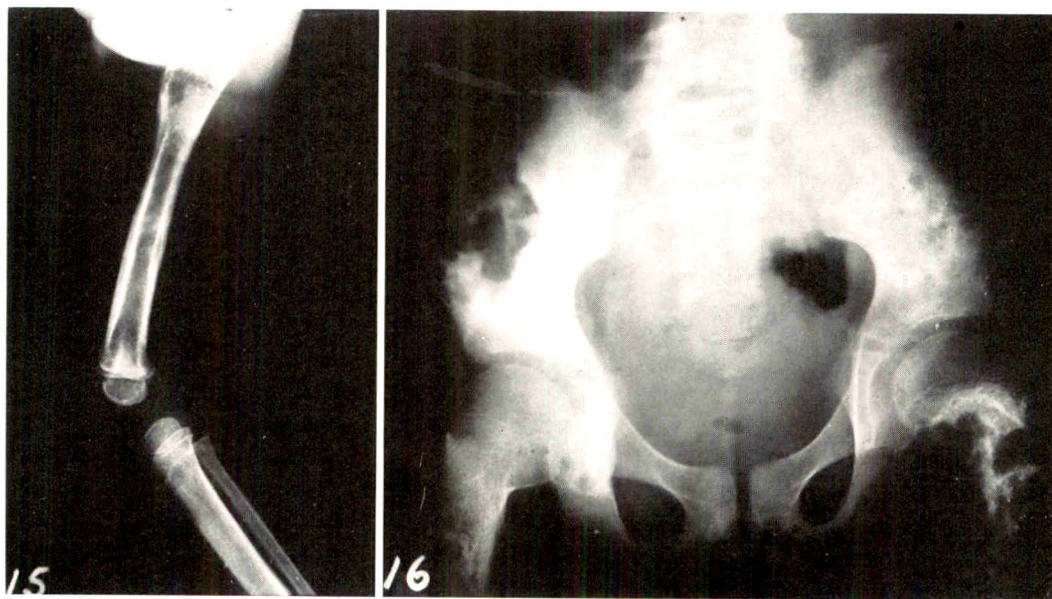


FIG. 15. Irregular defects of humerus and ribs with dense bony tissue layer inside the periosteum. Changes in many other parts of the skeleton.

FIG. 16. Extensive bone defects in the pelvic bones and femur showing the same change as in the skull.

that when there has been involvement of the pituitary gland, destructive changes in the sella and roentgen evidences of tumor have been found in less than one-third of the cases studied.

While the bone defects are the most striking symptom, the endocrine manifestations that may develop in the course of this affection are an interesting clinical feature. The characteristic pathologic change has been found in all the glands of internal secretion, in the thymus, testicles, suprarenals, pancreas, pineal, thyroid and parathyroids, and especially in the pituitary gland. All the cases that have been examined histologically show this change in varying degree.

The symptoms usually ascribed to endocrine factors in Schüller-Christian's disease are diabetes insipidus, growth disturbances, both somatic and sexual, and retardation of intellectual development. Diabetes insipidus is a cardinal symptom occurring in a large proportion of the cases. Associated with it, lipidosis occurs extensively in the hypophysis, tuber cinereum, and surrounding region at the base of the brain. It also has been observed, in several instances, that the pituitary was pushed up out of the sella by the new formation. Growth arrest has been most evident in cases in which the disease developed in early childhood but it occurs in adolescent cases along with hypogenitalism. In such cases there may be a rapid development of obesity and change in the hair growth. In the rare adult form there has been extreme emaciation and pigmentation suggesting Addison's disease or an increased growth in the facial bones, hands and feet, along with an atypical form of diabetes mellitus and lipemia. The patient with Simmonds' syndrome had a fibrosed anterior pituitary and those showing acromegalic symptoms had lipidosis in the pituitary, surrounding region at the base of the brain and other endocrine glands, which seems to indicate that the endocrine disturbance is the result of the lipidosis.

All this is of considerable interest because the changes in the bones have so frequently been regarded as related to endocrine influence. The diabetes insipidus, retarded growth and hypogenitalism as well as the rare Simmonds syndrome and acromegaly can be ascribed to the endocrine factor as well as the bone growth changes which occur late in the acromegalic cases, and there may be other endocrine influences affecting the bones in the later stages of this disease. But there seems to be no real evidence that the bone defects result from such a cause. They seem rather to be the outcome of the general pathologic change brought about by the excessive deposits of lipids in the tissues, and their variations in the late form of the disease are caused perhaps by the different stages of the healing process.

Our knowledge of the metabolism and chemistry of this affection is quite incomplete. The fact that we find large amounts of lipid deposited in the tissues is the main evidence for regarding Schüller-Christian's disease as a lipid metabolic disturbance. It is thought that in health there is a certain definite quantitative equilibrium or relationship among the fat-like substances in the body. If their balance is disturbed and any of the elements are in excess or diminished, the normal relationship is upset, one or more of the lipid constituents are deposited in the tissues, and a pathologic change results. It has been suggested that this disturbed equilibrium is in some way related to a disturbed liver function. Very few investigations have been made concerning the inorganic metabolism in this disease. The calcium values are normal or low, a fact which is interesting in an affection so extensively involving the skeleton.

There are many problems which need investigation in this constitutional disease. If some of my conclusions are still hypothetical I trust I have given a correlated picture of symptoms, pathology and endocrinologic features which may be helpful in a further roentgenologic study of this and other bone diseases.

REFERENCES

1. CHIARI, H. Die generalisierte Xanthomatose vom Typus Schüller-Christian. *Ergebn. d. allg. Path. u. path. Anat.*, 1931, 24, 396-450.
2. HENSCHEN, F. Ueber Christians Syndrom und dessen Beziehungen zur allgemeinen Xanthomatose. *Acta paediat. (suppl. 6)*, 1931, 12, 1-93.
3. MOREAU, J. La dysostose hypophysaire. *Arch. franco-belges de chir.*, 1930, 32, 697; 865; 961. Monograph, 1931.
4. PINCHERLE, M. La syndrome di Hand-Schüller-Christian. *Arch. ital. di pediat. e puericul.*, 1932, 1, 1-62.
5. ROWLAND, R. S. Anomalies of Lipid Metabolism. Oxford Medicine, Oxford University Press, New York and London, 1932. Vol. IV, pp. 214 (3)-(214 (109). (Literature.)

DISCUSSION

- DR. P. F. MORSE, Detroit, Mich. I think there are only one or two things of any importance that concerned my department in this condition. This disease of Schüller-Christian is one of lipoid metabolism, characterized by a peculiar type of lipoidal granulation tissue. This material when you see it at post mortem occurs in yellow, inflammatory gumma-like masses. The whole base of the skull will be invaded by a peculiar yellow rubbery substance which has grown on and through the base of the skull, invaded the orbit, deformed structures at the base of the skull or whatever mechanical derangements may have resulted purely by accident from the growth of this gummatous, inflammatory tissue. I have always been impressed by the interesting fact that the oldest lesion in the body of these children is in the lungs. They have a diffuse pulmonary fibrosis, a chronic fibrous pneumonitis as the oldest lesion in the body. That is interesting in view of the fact that some of the French workers have claimed

and others denied that the lung is the organ for elimination of cholesterol in the body, and that these cases are primarily hypercholesterinemia, resulting in an irritation strain on the lung which results in the fibrosis.

The bone lesions in this disease are not primary at all. They are not connected with calcium or metabolism. They do not belong to the primary malacic group as do osteitis fibrosa cystica and osteomalacia, but you have bone defects in Schüller-Christian's disease for the same reason that you have bone defects in aneurysm; that is, from pressure on the bony structures. This yellow, inflamed, gumma-like tissue is particularly erosive to bone and bone destructive, and wherever it grows the bone dissolves away. That is why there isn't a high blood calcium and an increased excretion in the urine because it isn't primarily a calcium disturbance. You never find a bone defect in Schüller-Christian's disease unless there is the yellow lipomatous tissue to make the defect.



ERYTHROBLASTIC ANEMIA*

(COOLEY'S SYNDROME)

By F. F. BORZELL, M.D.
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A REVIEW of the literature upon the subject of congenital anemias is hardly necessary, especially since it has been so thoroughly covered by Baty, Blackfan and Diamond¹. They reported 20 cases in addition to a review of 26 cases previously reported by various authors. They found no material improvement resulting from splenectomy except in the cases reported by Hitzrot. Concerning therapeutic application of roentgen rays, they consider that its use has been insufficient to judge accurately. Vogt and Diamond state that no form of therapy has been of any avail.

Cooley and his coworkers, who in 1927 first described the syndrome they called erythroblastic anemia, expressed the belief that splenectomy in addition to relieving the child of the burden of the enormous spleen

may retard the progress of the disease.

The 3 cases here reported were submitted to roentgen therapy, one child on the service of Dr. Ralph S. Bromer and two on my service. The older patient (Figs. 1, 2, and 3)

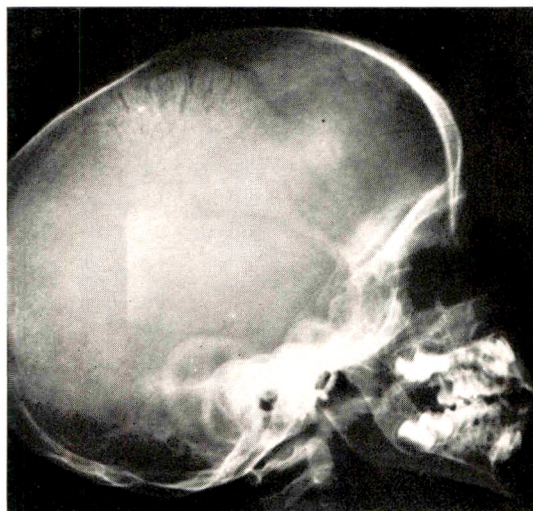


FIG. 1. Case 1. Diagnosis, erythroblastic anemia. Note beginning striation in calvarium; trabeculation of facial bones.

¹ Baty, J. M., Blackfan, K. D., and Diamond, L. K. Blood studies in infants and in children; erythroblastic anemia. *Am. J. Dis. Child.*, 1932, 43, 667-704.

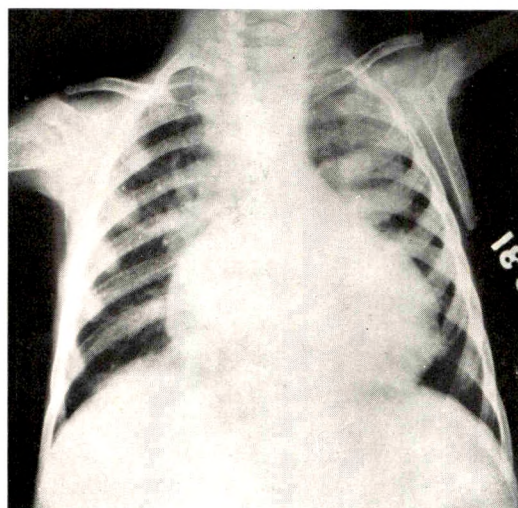


FIG. 2. Case 1. Roentgenogram showing bronchopneumonia, pulmonary exudate; trabeculation of clavicles and scapulae, and globular heart.

on my service, who was desperately ill when treatment was instituted, failed to respond in any way. On the contrary, the child became rapidly worse and died soon after from pneumonia. A post-mortem examination was made. The autopsy findings are given with the report of the case.

The younger child (Figs. 4 and 5), a sister, was not as far advanced a case as her sister. She appears to have improved following therapeutic application of roentgen rays. The spleen was reduced to normal size, the weight increased and appetite improved. The bone changes have apparently not progressed; in fact, there seems to be

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

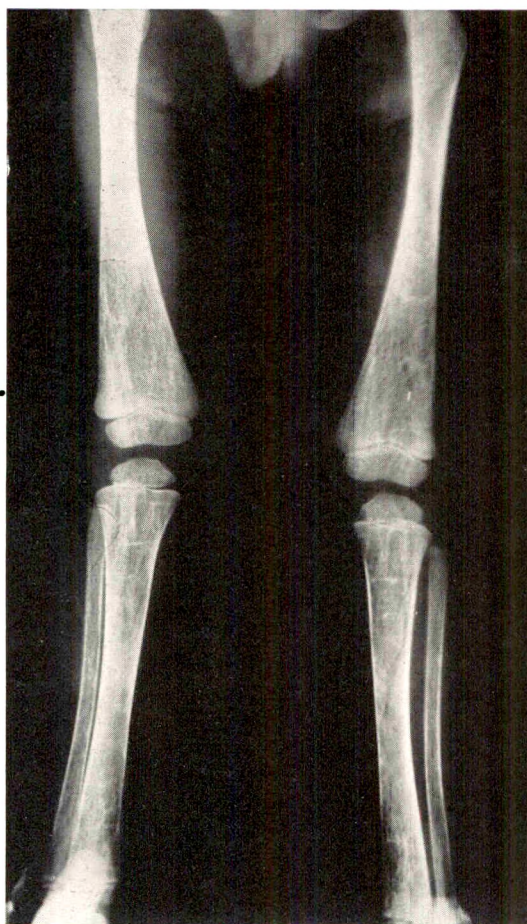


FIG. 3. Case I. Note expansion of shafts and thin cortex, irregular trabeculation, and slight transverse striation.

some improvement. The blood picture, however, does not appear so hopeful. Hemoglobin has dropped to 25 per cent; leucocytes have remained about stationary. In January they numbered 14,500. The last examination two months ago showed 7,100. Erythrocytes have ranged from 1,970,000 to 1,590,000 in that time. There was some decrease in the number of erythroblasts and immature cells. Strangely enough, few normoblasts were reported but I doubt the accuracy of the differential count. My reasons for this are based on the absence of an accredited pathologist during this period and the fact that the first blood counts were checked by other laboratories, at which time the nucleated red cells num-

bered several hundred per 1000 counted. The high percentage of lymphocytes sometimes counted suggested the possibility of error in recognition of erythroblasts.

It is quite possible that the apparent improvement following irradiation may be a period of remission but I have found no instances recorded where the spleen was actually reduced in size and where clinical im-

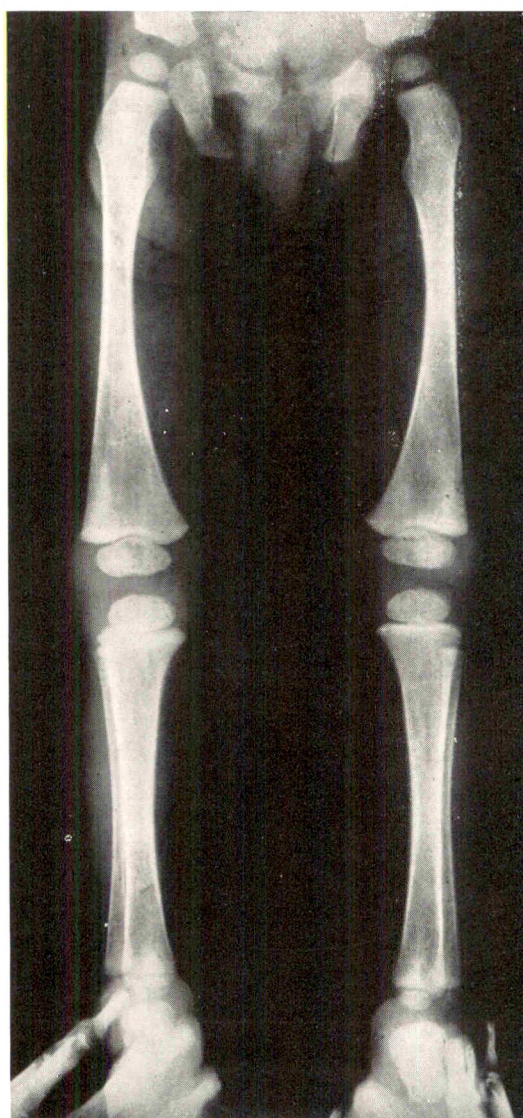


FIG. 4. Case II. Diagnosis, erythroblastic anemia. First examination. Note the prominent trabeculation of the bones of the pelvis and long bones; medullary rarefaction and thin cortex of long bones.

improvement was noted following any form of treatment, other than splenectomy, and then, as pointed out by Cooley, it was only temporary. We are disposed to consider that the results obtained were due to the institution of treatment in an early stage. Nevertheless, unless future observations show a decided improvement in the blood picture we are not sanguine concerning the ultimate result. The expression by Dr. Cooley that these patients were making bricks without straw would seem to be a succinct statement of the state of affairs until such time as we can determine what factors constitute the straw.

The roentgen treatment consisted of five series at monthly intervals. The areas exposed were the spleen and the long bones of the legs, the latter as one area. One area only was treated at each visit, at which time 100 r was given with 6 mm. Al filtration at 40 cm. distance, 130 kv. On the alternate day the other area was exposed in like manner. This was done for two exposures over each area.

After the fifth month, treatment was discontinued and when the patient returned eight months after the first treatment was instituted, the improvement previously noted was observed.

We have included in this series a report of another case of erythroblastic anemia (Figs. 6, 7, and 8), through the courtesy of Dr. Ralph S. Bromer. This patient was also treated by radiation but with no improvement. The bones of this patient show almost as marked changes as those noted in our fatal case. The bone changes noted in the case which responded were not nearly so marked. The differences were: no changes in the calvarium, less marked thinning of the cortex, less prominent trabeculation and no marked cardiac enlargement. As the patient improved there appeared a greater tendency to transverse striation, particularly at the metaphyses, together with definitely increased density of the metaphyses.

For purposes of record, we have appended the report of a case of sickle cell anemia

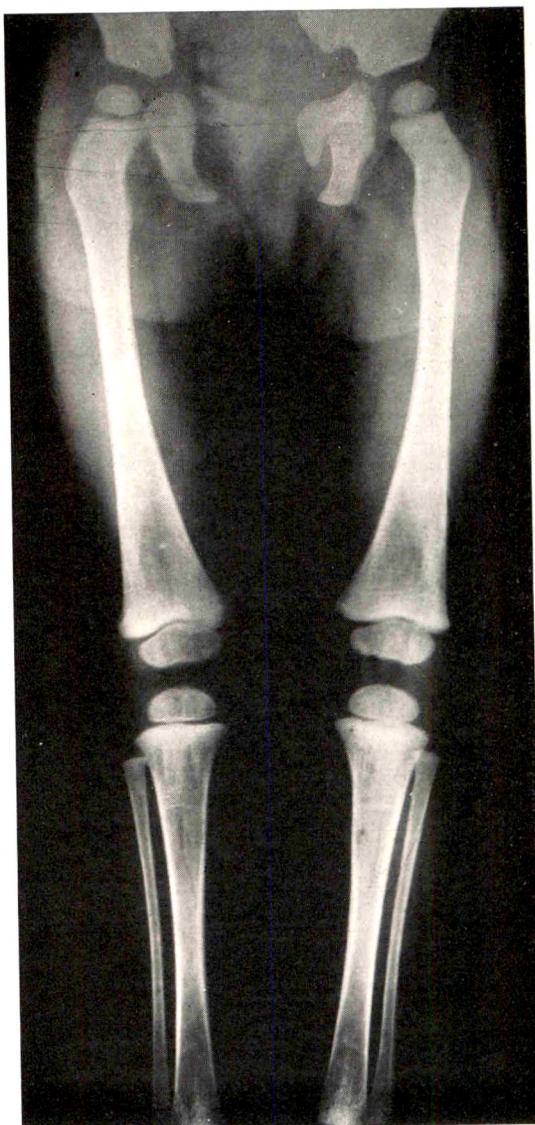


FIG. 5. Case II. Note the slightly increased bone density. Less marked trabeculation. Increased transverse striation, following roentgen treatment.

(Figs. 9 and 10), also through the courtesy of Dr. Bromer, and one case of celiac disease, on my own service, accompanied by profound anemia. The bone changes in sickle cell anemia, as noted roentgenographically, have already been pointed out by Vogt and others. They are similar in some respects to those found in erythroblastic anemia, but not by any means as profound. Nevertheless, the changes noted in our second case of erythroblastic anemia resem-

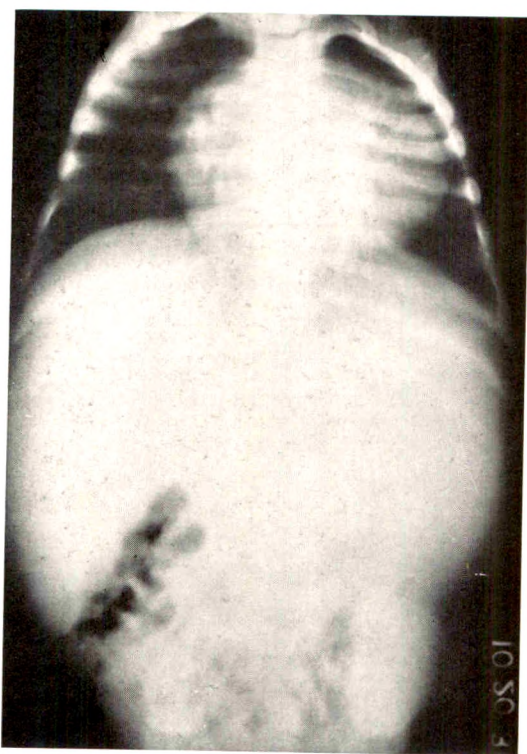


FIG. 6. Case III. Diagnosis, erythroblastic anemia. Roentgenogram shows enlarged globular heart; accentuated trabeculation of ribs.

ble somewhat more closely those of the case of sickle cell anemia. This would tend to bear out the observation already made by Cooley that the bone changes in the anemias of childhood are not primary. May it not be that the roentgen evidences of change are an index of the severity of the anemia?

With this thought in mind we have included a report of a case of celiac disease accompanied by profound anemia (Figs. 11, 12, and 13). Celiac disease, or intestinal infantilism of Herter, is a disease of infancy, characterized by extreme carbohydrate intolerance. The diagnosis is based upon: retardation of growth, large, offensive, gray-colored stools, distended abdomen, peevish disposition and intolerance to carbohydrates. Reports of roentgen studies are rather meager. Neff says, "The bones are small and ossification of cartilages is delayed." Marriott reports essentially the same. Levinsohn states, "Osteoporosis is

common, caused possibly by a negative balance or a B. avitaminosis. Spontaneous fractures occur. Delayed development of ossification centers are demonstrable. 'Year rings', evidence of periods of delayed growth, can be seen by X-ray."

The patient presented certain roentgenographic evidences which led to a report of some form of congenital anemia before we saw the blood picture and without any knowledge of the clinician's diagnosis. We believe the evidences seen were due partly to the profound anemia and partly to the growth retardation as caused by the intestinal disturbance. The blood picture was as follows: Hemoglobin, 50 per cent; red blood cells, 3,330,000; white blood cells, 7,500; polymorphonuclears, 53 per cent; small lymphocytes, 38 per cent; large lymphocytes, 5 per cent; eosinophiles, 1 per cent; 5 normoblasts; 2 microblasts; 2 megaloblasts; red blood cells markedly irregular in size and shape.

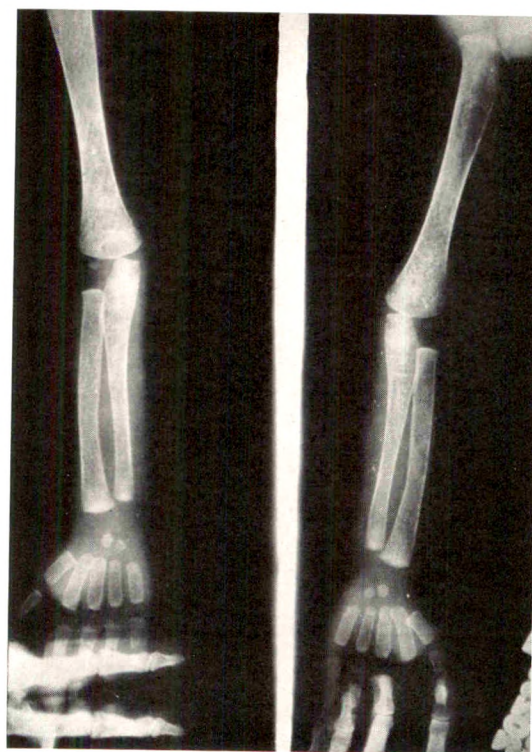


FIG. 7. Case III. Note the characteristic cortical thinning, medullary rarefaction, prominent irregular trabeculation.

The spleen was somewhat enlarged. The skull presented only slight changes, characterized mainly by slight trabeculation, slight widening of medullary space particularly in the frontal and parietal regions. The pelvis showed definite trabeculation as did the femora and tibiae, with some suggestion in the hands and feet. The distal diaphyseal ends of the femurs and both diaphyseal ends of the tibiae presented some transverse striations, the so-called "year rings" of Levinsohn. The medullary portions of femora and tibiae suggested some osteoporosis. The scapulae and ribs also indicated accentuation of the normal trabeculation.

Although the anemia in this case was obviously a profound secondary anemia, undoubtedly the nutritional disturbance brought about sufficient demands on the reticulo-endothelial system to cause roentgen evidences.

Although the picture of erythroblastic anemia from a roentgenographic standpoint is totally dissimilar to that seen in this case of severe secondary anemia, there appear to be sufficient points in common between the less advanced case of congenital anemia and the secondary anemia to suggest further studies along these lines.

The opinions herein expressed are based on too few cases to warrant any presumption of conclusions.

CASE REPORTS

CASE I. M. R., female, aged two. American born of Italian parentage. Admitted to Burlington County Hospital, New Jersey, September 23, 1931. Diagnosis of splenic anemia.

Chief Complaint. "Not enough blood."

Personal History. Normal infant at birth, normal delivery. One of twins, the other twin born dead. Weight 10 lb. at birth. Breast fed for eight months. Did well until six months old when she became pale and fretful. Lost weight. Admitted to Philadelphia Hospital. Remained for ten days, was given two transfusions, then taken home against advice. Has been under attention of various physicians since, with remissions and exacerbations. Appetite fair, no vomiting. Bowels regular. Frequent urination, dark in color at times. Abdomen had always been

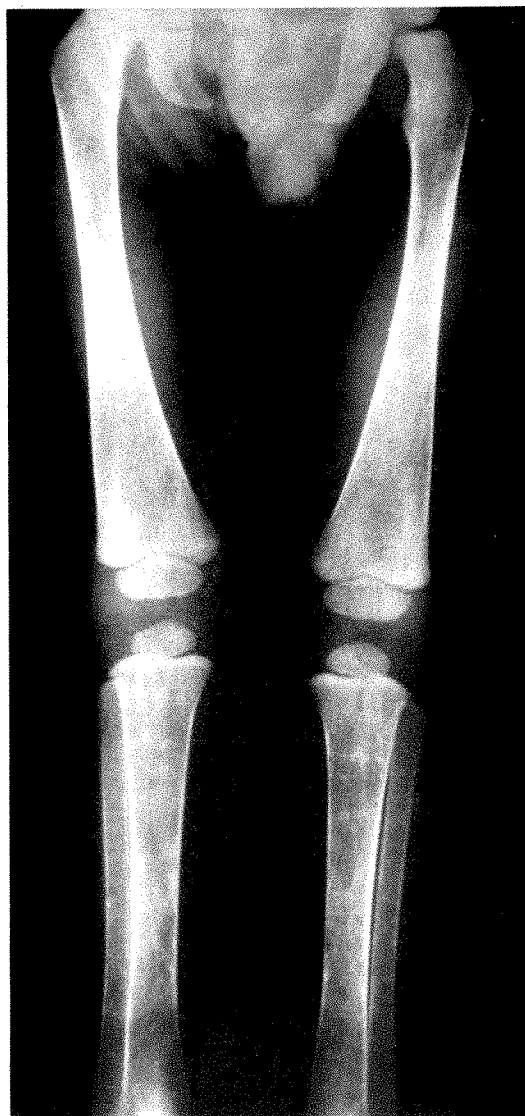


FIG. 8. Case III. This also shows the characteristic cortical thinning, medullary rarefaction, and prominent irregular trabeculation.

large. Apparently slight temperature at times. No cough or cold. Fretful. Mother not strong; father well. One older child living and well; one child dead, cause unknown; one child a year old suffering similarly to patient.

Physical Examination. Extremely pale and emaciated. Skin dry and of curious yellow color. Coughs frequently. Bluish white sclera. Mucous membrane pale. Enlarged tonsils. Some enlargement of lymph nodes of neck; those of axillae and groins palpable but not markedly enlarged. Respirations somewhat rapid, slightly impaired resonance. Breath sounds dimin-

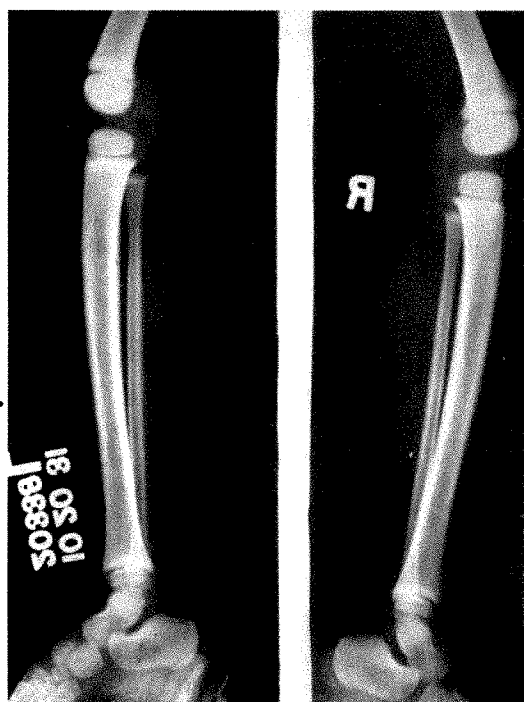


FIG. 9. Case IV. Diagnosis, sickle cell anemia. Note the slightly transverse striation near the proximal metaphyses of tibiae.

ished over bases, posteriorly. No râles noted. Abdomen quite prominent. Liver apparently enlarged, palpable about 2 fingers below costal margin. Spleen markedly enlarged, palpable as mass extending to level of anterior superior spine. Definitely notched. Extremities grossly negative.

Roentgen Findings. October 24, 1931. Examination of the lower extremities and skull

shows the following: The long bones of the legs show decided generalized decalcification with thinning of the cortex, some widening of the distal portion of the diaphyses of the femurs, an irregular porosity of the medullary portion with evidences of fine trans-striation, all of which are characteristic of an erythroblastic anemia. The calvarium shows distinct thickening of the frontal bone with some roughening and striations at right angles to cortex at the vertex and along the upper parietal region.

November 4, 1931. The upper extremities, ribs, vertebrae, clavicles and pelvis all show advanced evidence of the pathology noted in the lower extremities. The ribs are particularly porous and are almost devoid of any cortical ossification.

September 23, 1931. Examination of the chest shows the heart decidedly enlarged, globular in shape, with all its chambers much enlarged. The left apex shows great decrease in aeration. There is accentuation of all the peribronchial and parenchymal markings throughout both lungs with some evidence of slight studding in the left apex. The right interlobar pleural septum is somewhat thickened.

Conclusions. Cardiac enlargement. The pulmonary appearance is very much like that of bronchopneumonia.

Specimens sent to other laboratories for check-up showed from 158 to over 200 normoblasts; 66 per cent lymphocytes reported from one laboratory with the notation that quite a number of these might have been normoblasts. This was because of the apparent age of the smears that were submitted to the other laboratories.

The author has serious reason to believe that

Blood Examination

	9/25/31	9/27/31	1/6/32
Hemoglobin	25%	35%	35%
Red blood cells	2,180,000	2,210,000	1,120,000
White blood cells	47,900	80,250	26,800
Small lymphocytes	46%	Lymphocytes and lymphoblasts	37%
			73%
Large lymphocytes	1%		4%
Neutrophils	23%	21%	55%
Lymphoblasts	30%		Normoblasts 2
		Myelocytes 6%	Anisocytosis, poikilocytosis and polychromatophilia present in marked degree.
		Anisocytosis	
		Poikilocytosis	
		Polychromatophilia	
		Basophilic degeneration	
		Reticulocytes 3%	

the differential count made at the hospital was inaccurate because of the absence of a skilled pathologist.

During the course of illness the child developed evidences of pleural effusion with a bronchial pneumonia. Transfusion was resorted to in several instances. Roentgen treatment was applied, giving 100 r over the spleen. The patient's condition was such that further roentgen treatment was not permitted and the patient died on January 6, 1932.

Autopsy Report. Subject that of a female child, two years of age, markedly emaciated. No external abnormality found other than a transparency of the skin, peculiar of extreme anemia.

Thorax and abdomen opened through the usual midline incision.

Lungs: Freshly formed pleural adhesions found over both lungs, the right side being, however, more extensively involved. About 2 to 3 ounces of dark, flaky fluid found free within the left pleural cavity. Except for congestion at bases the lungs proper were found normally filled with air.

Heart: Increased amount of pericardial fluid and dilatation of the right side noted. The myocardium and endocardium, as well as the valves of the great vessels and heart, were normal. The mediastinal glands were enlarged somewhat but were discrete and not calcified.

Abdomen: Marked distention of the stomach as well as coils of small and large intestines. Other than this there were no gross abnormalities to be seen along the gastrointestinal tract.

Liver: Weighed 1 pound 6 ounces. It was dark brown in color, showing the unusual mottling due to increased lobular markings. Capsule was not thickened, stripped easily and showed no adhesions. Cut surface was somewhat granular and gave the impression of increased interstitial fibrosis.

Spleen: Markedly enlarged (weighed 4 oz.) and showed perisplenic adhesions over the posteromedial surface. It felt hard and nodular and was covered with an adherent thickened capsule. Cut surface was slate colored and granular, bleeding very little. Apparently there was marked increased interstitial and perivascular fibrosis.

Kidneys: Normal in shape and position. Capsule stripped easily and was of normal thickness. Cut surface showed normal proportion between thickness of cortex and medulla.

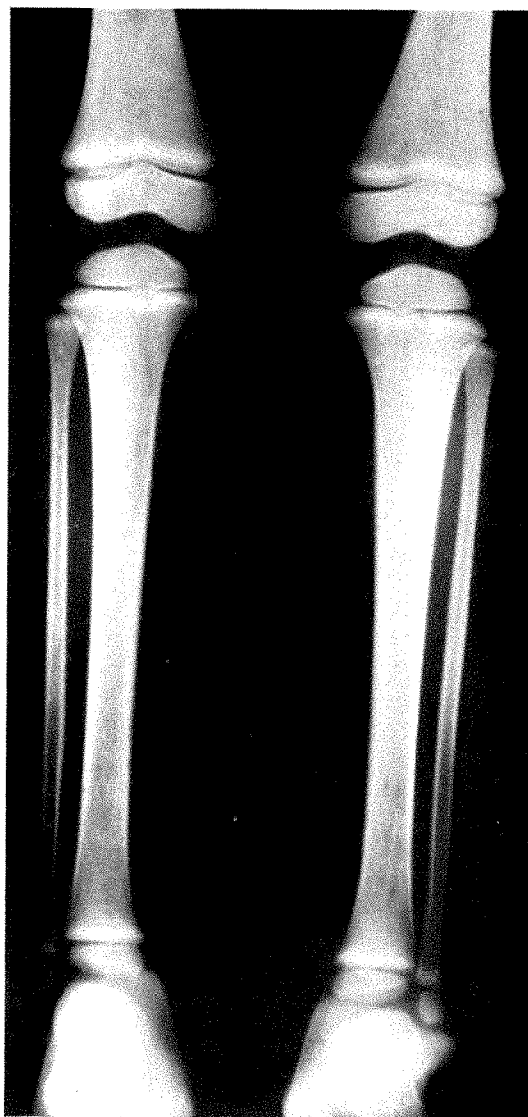


FIG. 10. Case iv. Shows the tendency to transverse striation in all metaphyses.

Mesenteric glands were enlarged.

Pancreas was normal.

A section of bone marrow was removed from the left tibia for microscopical examination.

Microscopical

Bone Marrow: Hyperplasia as shown by increased numbers of very young cells of the reticulo-endothelial series.

Lung: Areas in which alveoli are filled with fibrinous exudate but no migratory cells. Congestion of vessel around alveoli.

Gross Pathological Diagnosis: (1) Right-sided cardiac dilatation. (2) Pleurisy with effusion

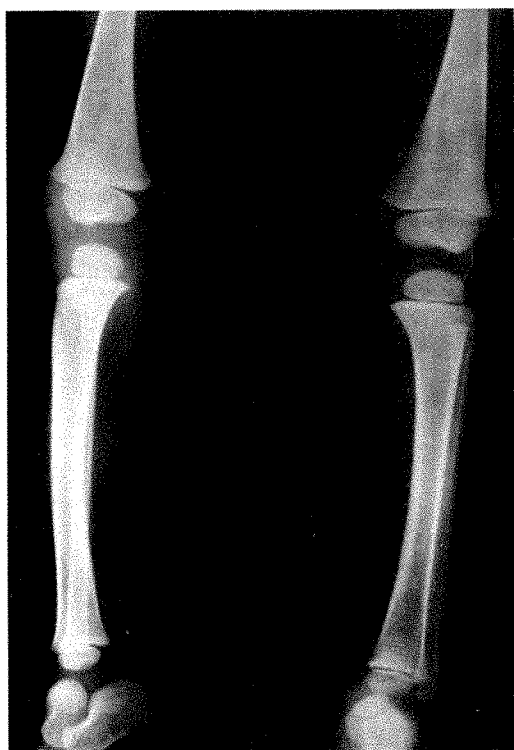


FIG. 11. M.D., aged two, American. Diagnosis, celiac disease. Note the slight medullary rarefaction; somewhat thin cortex; transverse striations at metaphyseal ends; accentuated trabeculation of bones of the feet.

on the left and plastic pleurisy on the right side.
(3) Hepatitis and splenomegaly (with fibrosis).
(4) Bone marrow hyperplasia.

CASE II. S. R., female, aged thirteen months, sister of Case I. Italian parentage, born in the United States.

Chief complaint on admission was paleness like older sister.

Personal History. Normal full term delivery. Breast fed for several months, then milk formula. At present time takes whole milk, cereals and vegetables. Has good appetite and normal stools. Her skin has been growing pale and yellow just as older child's did. Has no definite acute illness. Admitted for study.

Family History. Older sister in hospital with diagnosis of anemia. Father and one other child living and well. Mother living but not robust. Two children dead, one at birth and other from unknown cause.

Physical Examination. Poorly developed and undernourished Italian child of distinctly Mongoloid features, not as marked as those of the sister. The skin is a peculiar grayish yellow. Mucous membrane somewhat pale. Tonsils moderately enlarged. Lungs apparently clear. Abdomen prominent, liver slightly enlarged. Spleen enlarged, extending almost to umbilicus and downward to level of iliac crest. The remainder of the physical examination is irrelevant.

The temperature course was essentially negative.

Roentgen Findings. October 24, 1931. Examination of the lower extremities and the skull shows the following: The long bones of the legs present decided generalized decalcification with thinning of the cortex, some widening of the distal portion of the diaphyses of the femurs, an irregular porosity of the medullary portion with evidences of fine trans-striation, all of which is characteristic of an erythroblastic anemia. The calvarium fails to reveal any evidence of bone changes except for a slight tendency to thickening of the frontal bone.

November 4, 1931. Both upper extremities show the same characteristic evidences of thin-

Blood Picture			
	10/24/31	11/15/31	
Hemoglobin	45%		25%
Red blood cells	2,390,000	2,600,000	1,590,000
White blood cells	28,450	43,500	7,100
Small lymphocytes	40%	52%	86%
Large lymphocytes	40%	52%	14% neutrophils
Polymorphonuclears	34%	8%	1 Normoblast
Large mononuclears	26%	Lymphoblasts 32%	Red cell showing basophilic degeneration
		Normoblasts 5%	Anisocytosis and poikilocytosis
		Marked anisocytosis	
		Marked poikilocytosis	
		Basophiles	
		Several Cabot's rings	

ning cortex as the lower extremities. The ribs also show suggestion of the same pathology.

Roentgen therapy was discontinued in June. Since that time the child's condition has been clinically improved. She has gained weight and strength and appetite is good. The spleen has been reduced until it is only partly palpable. The blood picture, however, is not materially improved and at the last examination hemoglobin dropped to 25 per cent. There is, apparently, some improvement in the aberrant cells.

Further roentgen examinations of the long bones showed no advance in bone changes and definite tendency to return to normal.

At the first examination, no attempt was made at an accurate differential count.

Second report: About this time, control examinations were made at several other laboratories and large numbers of normoblasts were found. We believe that because of local laboratory conditions existing at this time the differential examination was not as accurate as it should have been. This applied to most of the blood counts.

CASE III. S. M., male, aged three, Italian.



FIG. 12. Same case as Figure 11. Shows accentuated trabeculation of pelvis and femurs.

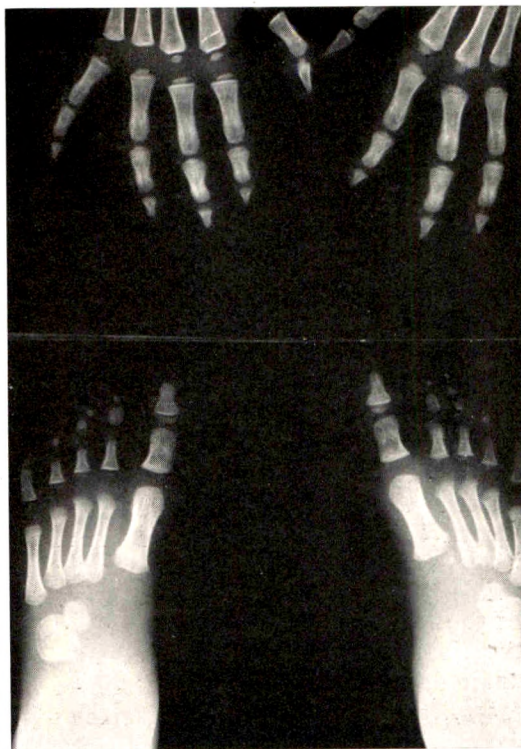


FIG. 13. Same case as Figures 11 and 12. Shows markedly accentuated trabeculation of hands and feet.

Admitted October 15, 1931, on service of Dr. Ralph S. Bromer, Children's Hospital, Philadelphia.

Chief complaint was large abdomen, weakness and paleness.

Provisional Diagnosis. Splenohepatomegaly.

Family History. History obtained from grandmother by interpreter. Mother aged twenty-five and father thirty; living and well. No other children. Paternal grandmother had asthma. No history of tuberculosis, nephritis or cancer.

Personal History. Born at easy labor, breathed immediately and seemed well. Birth weight 9 lb. Health during infancy was good until six months of age. Gained weight well. Sat up at three months. Never breast fed, given half milk and half water with a little sugar and lime water. Cod-liver oil and orange juice after seven months of age. Started to feed vegetables and bread at age of five months. Sleeps well unless eating before bed. Has had no contagious diseases or colds. Apparently well until six months old. At that time he began to vomit a great

deal nearly every day. When he would vomit much it was noted that he would have fever. The infant was given medicine by a doctor whereupon he improved somewhat but later vomiting and fever returned. Gained and lost weight spasmodically but did not gain steadily. After six months of age, his abdomen began to enlarge gradually for a year. Later it became larger and larger. Child was very constipated. After he was a year and a half old the abdomen seemed to remain stationary in size, but the constipation continued. He became more pale. About three months ago it was noticed that his abdomen became smaller, rather gradually and the constipation became less marked. He now has movements two or three times daily. Grandmother thinks he has improved during the last three months.

Physical Examination. Patient is a small and poorly nourished white male of about three years who does not seem acutely ill. He is somewhat jaundiced and has a very large abdomen in comparison with the rest of his body. Skin is jaundiced, otherwise negative. Glands—anterior cervicals are enlarged; epitrochlears can be palpated on the right arm. Head—large frontal bosses, forehead is high and square. Anterior fontanel is closed. Hair is thin, scalp has a few dry crusts. Ears—drums are both negative. Eyes—sclerae slightly yellow. Pupils react to

light and are equal. Conjunctivae are pale. Nose is clean. Mouth—lips are pale, caries of a few teeth. Mucous membranes are clean and clear. Pharynx is clear. Tonsils are present but are not enlarged. Neck adenopathy present. No rigidity, pulsation of jugular can be seen. Chest is small and emaciated. Ribs stand out prominently. Pulsation of heart can be seen in the 5th interspace. Chest seems to be symmetrical. Lungs—breath sounds are vesicular. Percussion note is resonant, no râles. Heart rhythm is normal, apex beat is in the 5th interspace 1 cm. outside the nipple line; left border is about 1 cm. beyond the nipple line. A systolic murmur can be heard over the chest, loudest over the mitral area. Abdomen is very large. The spleen is easily felt, extending down into the pelvis. It is hard, smooth and the edge is rather sharp. The notch can be felt. When lying down the edge of the spleen can be seen through the abdominal wall. The liver is large and extends a full hand's breadth below the costal margin. It is soft and smooth, the edges are round. No tenderness and masses can be elicited. Extremities—no deformities. The musculature is poor. Patellar reflexes are well marked. Ankle clonus, Babinski's and Kernig's are absent.

Impression. Splenic anemia, or Gaucher's disease.

Blood Picture

	10/15/31	2/17/32	2/19/32	8/5/32
Red blood cells	2,930,000	2,820,000	2,820,000	1,630,000
White blood cells	23,000	16,600	15,000	6,600
Hemoglobin	25%	38%	52%	19%
Neutrophils	52%		68%	78%
Lymphocytes	19%		20%	6%
Large mononuclears	15%		12%	2%
Eosinophiles	5%			10%
Basophiles	1%			
Myelocytes	8%			
Polychromatophilia				
Anisocytosis				
Poikilocytosis				
Basic degeneration				
Howell-Jolly bodies				
Cabot's ring bodies, occasional				
Normoblasts, 281				
Megaloblasts, 36				
Mitotic figures				
Platelet count 260,000 per c.mm.				
Fragility test for red blood cells				
Beginning hemolysis	0.40			
Complete hemolysis	0.22			

Megaloblasts, 296 counting
 Normoblasts, 438 100 W.B.C.
 Microblasts, 2
 Few degenerated cells
 8/5/32

Roentgen Report (Dr. Ralph S. Bromer). Examination of the spine and pelvis shows a slight tendency to rarefaction.

Long bones and skull. Perpendicular striations such as occur in erythroblastic anemias of the Cooley type or in the so-called congenital anemias. The changes in the long bones, namely, widening of the shaft and thinning of the cortex, with rather widely spread trabeculation shadows, and also perpendicular striations at the ends of the shafts, are typical.

Teleroentgenogram. There is a marked increase in the width of the right auricle and left ventricle shadows, also of the median arc, the heart having a globular shape. It is difficult to venture an opinion as to the cause of this without knowing more of the physical findings.

Treatment consisted of numerous blood transfusions with variable effect, mainly none. The child received an indefinite quantity of roentgen therapy but with no material change.

Splenectomy was then done, recovery satisfactory.

Further transfusions were given. Blood pic-

ture, however, failed to improve. Hemoglobin dropped to 15 per cent.

The patient was still living at the last report.

CASE IV. T. G., Male, aged four, negro.

Roentgen Findings. The long bones show slightly increased density of the zones of the temporary calcification, while the skull shows marked thickening of the outer table of the vertex of the occiput, due, I believe, to the anemia. The typical perpendicular striations are not present.

Blood Picture

	2/17/32
Red Blood cells	2,930,000
White blood cells	36,000
Hemoglobin	42%
Neutrophils	36%
Lymphocytes	53%
Transitional	8%
Eosinophiles	2%
Basophiles	1%
Complete sickling after standing overnight.	
Polychromatophilia—slight	
Achromia—slight	
Normoblasts—7 found while counting 100 leucocytes	



ROENTGEN IRRADIATION OF THE PARATHYROID REGION IN CYSTIC DISEASE OF THE BONES AND IN OSTEITIS DEFORMANS*

By E. A. MERRITT, M.D.

WASHINGTON, D. C.

IT IS not at all probable that cystic bone diseases have a common cause, but that many are dependent upon an increase of the parathyroid hormone is an established fact. To what extent this secretion influences other osteopathies and other diseases where calcium metabolism is involved furnishes abundant opportunity for speculation and study.

The inhibiting and destructive effects of radiation on the endocrines is of course well known, and the following cases are reported to show that the parathyroid glands are no exception to this rule.

A careful search of the literature fails to disclose any recorded evidence that roentgen therapy over the parathyroid region has ever been attempted as a therapeutic measure in cystic bone disease or osteitis deformans. One case reported here was classified as multiple myeloma, but the astonishing general improvement following roentgen treatment to the cervical region for the relief of pain raises the question if myeloma may not also be of endocrine origin.

Theoretically, at least, the best approach to parathyroidism is by radiation therapy and while all the cures of cystic bone disease hitherto reported have followed surgical removal of one or more parathyroid glands, there are and always will be obstacles which render surgical attack so difficult that irradiation, if reasonably successful, will become the method of choice.

CASE 1. The patient, female, white, unmarried, aged thirty-four, was referred to our Clinic at Garfield Hospital by Dr. Bullock of Washington, D. C.¹ Family history unessential.

Past History. Usual childhood diseases. Had

¹ Case report, *J. Am. M. Ass.*, May 13, 1932.

always enjoyed good health until January, 1928, when symptoms of hyperthyroidism developed. In addition to the cardinal signs there was a loss of 40 lb., insomnia, nausea, and vomiting, and marked muscular weakness. Prior to the subtotal thyroidectomy which was performed August 14, 1928, the B.M.R. was +23 per cent. Subsequent to the operation there was satisfactory general improvement to the point of perfect health for a year, when nervousness returned with all of the previous symptoms of hyperthyroidism which were thought by the patient to be "more severe than before operation." In addition, she complained of increasing stiffness and pain in the right knee which finally, together with symptoms of hyperthyroidism, produced complete disability. The patient was admitted by ambulance May 16, 1931.

Physical Examination. Emaciated white female, very nervous and apprehensive. Temperature 98.6°F.; pulse 98, respiration 20. There was a pronounced tremor of the fingers; slight bilateral exophthalmos; scar of a previous thyroidectomy with a rather firm bilateral moderate enlargement of the thyroid gland above scar; heart and lungs normal; abdominal viscera presented no demonstrable abnormality; B.M.R. +35 per cent; blood, urine and calcium determination not done; Wassermann negative; weight 95 lb.; right leg semi-flexed and could not be manipulated without producing excruciating pain in the knee joint. The knee was slightly swollen.

Roentgenograms of the right knee showed cyst-like areas of bone destruction involving the distal end of the right femur with definite periosteal proliferation. The cortex was broken through in places which doubtless permitted the egression of fluid resulting in bone proliferation. Chest and skull negative.

Treatment. Roentgen therapy was given to the neck over two areas including the thyroid and parathyroids, in the following dosage: 5

* From the Radiological Clinic of Groover, Christie and Merritt. Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

ma., 135 kv., 10-inch distance, 5 mm. Al filter, 6 minutes to each area.

On June 6, 1931, three weeks later, there was general improvement and almost complete relief of pain in the right knee. This attracted our attention and we, for the first time, noted the possible relation between the cystic bone disease, pain in the joint, and the parathyroids.

On June 27, the patient could walk very well without assistance and there was continued general improvement. The pain had entirely disappeared. Roentgen treatments were continued at three-week intervals to October 12, 1931, when there was scarcely a trace of hyperthyroidism or of the bone lesion.

The total number of treatments given was eight, the last being administered December 15, 1931, immediately after a basal metabolic rate determination, which was $+16$ per cent. The



FIG. 1. Case I. Cystic right femur before irradiation of parathyroids. May 16, 1931.

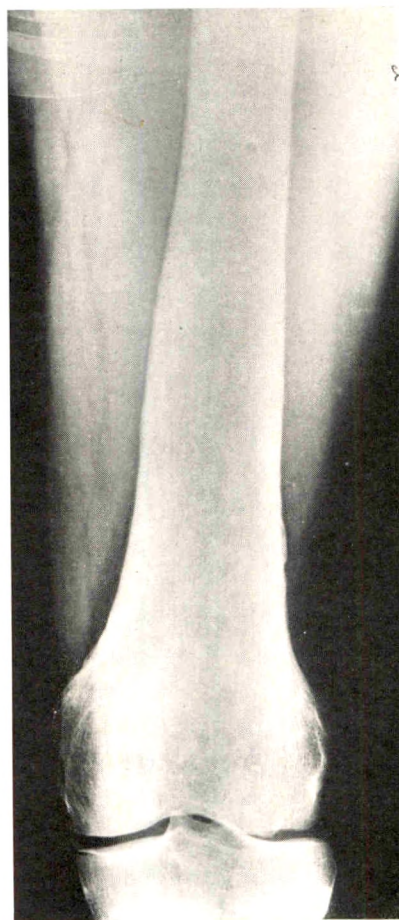


FIG. 2. Case I. After irradiation of parathyroids. September 12, 1932.

patient continued to gain in weight and health until the optimum of both was attained. She resumed her usual duties as a stenographer and was finally examined, photographed and discharged, September 12, 1932.

CASE II. Mr. X., white, married, aged fifty; referred by Dr. S. R. Karpeles of Washington, D. C., for general roentgen examination; occupation, designing draughtsman, Ordnance Department, U. S. Army. Family history unessential; wife living and well; one child aged twenty-four, living and well.

Past History. Rheumatism in 1923, in bed for two weeks; denies venereal disease; no tuberculosis contacts. Except as noted general health has always been excellent, and up to recent illness has been an active tennis player. Since 1917 he has averaged 1000 miles of railway travel per month in connection with his profession.

In February, 1929, patient was confined to bed for a day following a ride on a gun-carriage over a rough road. On March 6, 1929, while lifting a heavy weight he heard "something

appeared to have appreciated the nature or gravity of the case.

About September 21, 1930, he returned to work but suffered much pain in the back and

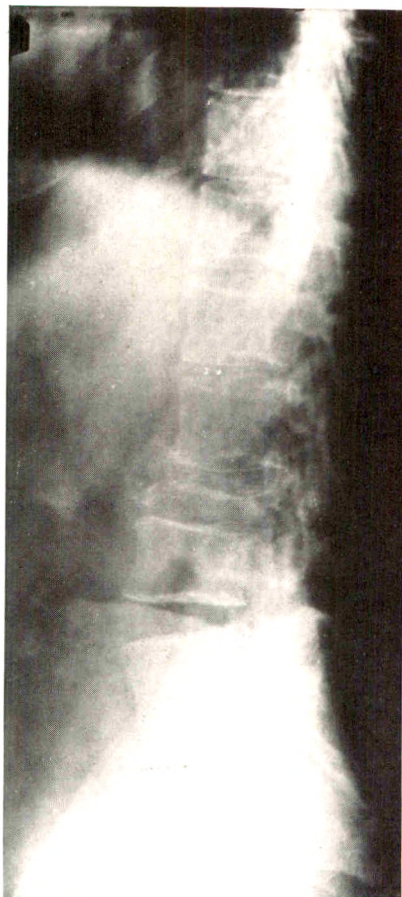


FIG. 3. Case II. Cystic bone disease showing vertebrae at onset of disease. June 6, 1930.

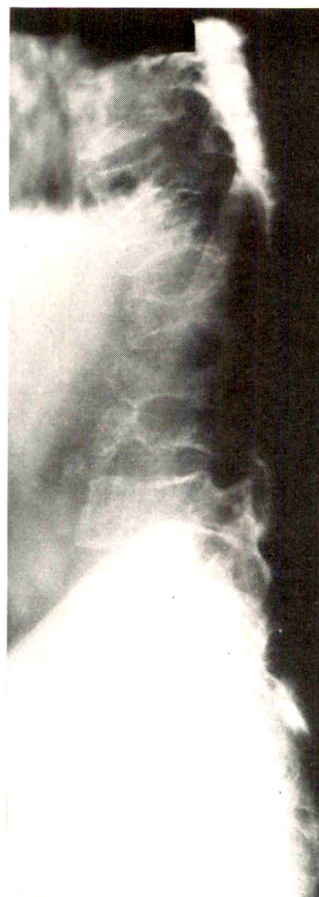


FIG. 4. Case II. Six months after irradiation of the cervical region. August 10, 1931.

snap" in his back and experienced intense lumbar pain which, however, "lasted only a minute." He resumed work next day and continued thereafter with but slight back pain until December 15, 1929, when he was "taken with lumbago" and remained in bed for two weeks, returning to work January 2, 1930. July 1, 1930, found him in bed again with a lame back, and under a physician's care for two months. About this time he was advised by a social worker to have his back x-rayed, which was done in a commercial laboratory. The patient was then seen by two successive orthopedists and the rather unsatisfactory roentgenograms were also submitted to them. Neither of them

could not lean over a drawing board or use a drafting machine. He was unable to raise a window, hold a telephone receiver to his ear or turn over in bed, and he discovered that his height had decreased from 5 ft. 8½ in. to 5 ft. 3½ in. He also noted an unusual prominence of his breast bone, a spinal deformity and pain radiating from back to left hip and thigh. Sneezing or coughing aggravated the back pain, and for two months before this examination the slightest exertion was followed by considerable difficulty in breathing.

Physical Examination. March 2, 1931. Patient is emaciated, anemic, dyspneic, and obviously in considerable distress. He stands with

legs widely separated and supports his back by placing hands on his hips. Shoulders elevated and appear square across. Neck shortened and head held forward. Upper third sternum concave; lower two-thirds convex. There is a marked kyphosis with maximum convexity from the 3rd to the 8th dorsal vertebra. Skin shows evidence of pressure over this region. Lymphatic system negative; other special examinations negative except heart which showed evidence of failing compensation accompanied by organic disease, and marked secondary anemia, but with no unusual blood elements; normal calcium content; urine negative except for presence of Bence-Jones bodies. Temperature ranged from 94° to 98.6°F. while under observation and treatment at Garfield Memorial Hospital where he was admitted March 9, 1931.

Roentgen examinations showed myriads of cystic areas in all bones from the cervical vertebrae

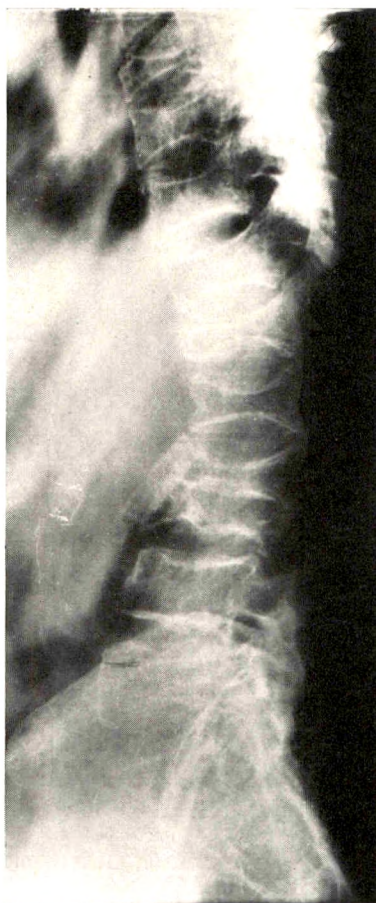


FIG. 5. Case II. Thirteen months after irradiation of the cervical region. September 12, 1932.

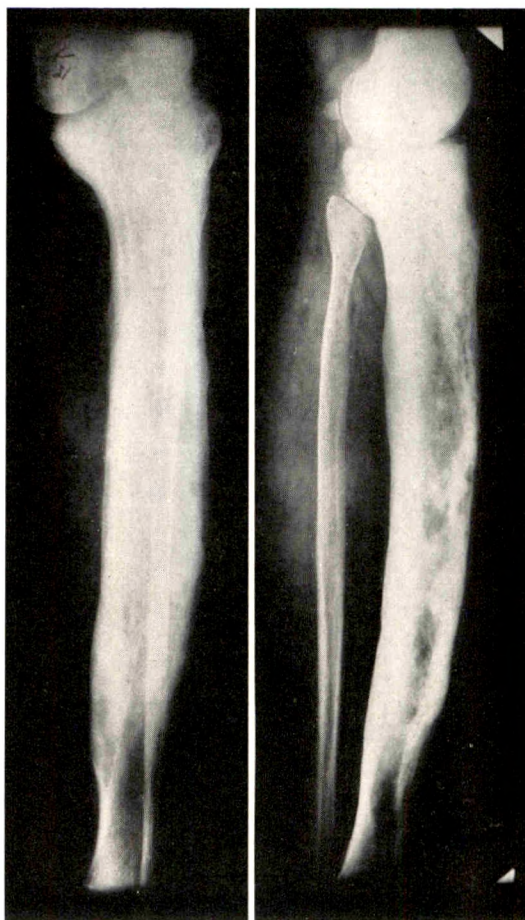


FIG. 6. Case III. Osteitis deformans of the left tibia before irradiation of the parathyroid region. October 8, 1931.

brae to the middle thirds of the femora. There was almost complete decalcification so that the bodies of the vertebrae scarcely registered on well made films. The last three lumbar vertebrae showed almost complete collapse and all the vertebrae showed marked narrowing. There was involvement of the proximal third of the right humerus. Chest examination showed evidence of chronic passive congestion and extensive involvement and deformity of the bony framework. Gastrointestinal study negative.

On the basis of roentgen findings and Bence-Jones bodies in the urine a diagnosis of "probable myeloma" was made.

Treatment. Absolute rest in bed. Special dietary measures for anemia, viosterol and deep roentgen therapy over lumbar, thoracic and cervical regions. A total of 1,800 ma-min. at 200 kv., 60 cm. distance, 0.5 mm. Cu and Al, over 9

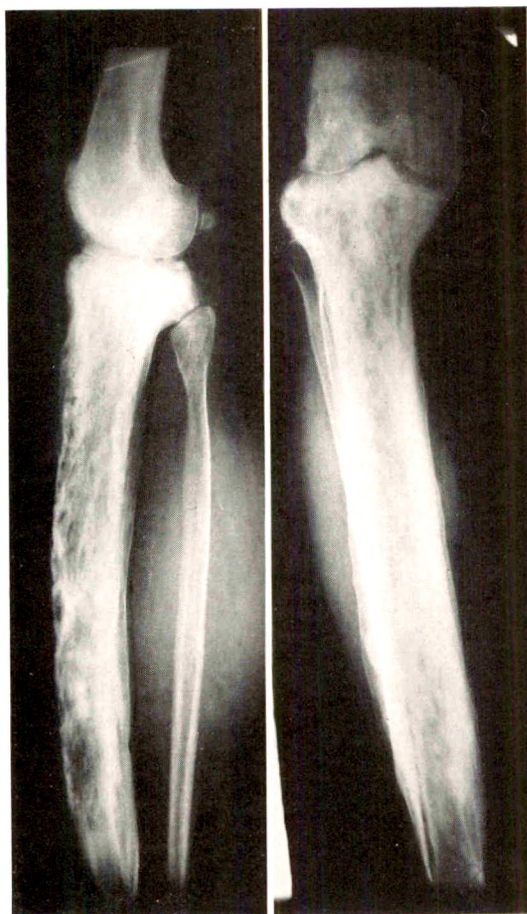


FIG. 7. Case III. Same bone four months after irradiation of the parathyroid region. February 18, 1932.

areas, posterior and lateral lumbar, and posterior and lateral thoracic regions from March 9 to 28, 1931. Patient returned to his home April 5, 1931, considerably improved. He returned to the hospital May 12, 1931, for additional irradiation because of intense pain in the cervical region. A total of one area, posterior cervical region, of 600 ma-min. was administered in two treatments on successive days at 60 cm. distance.

March 30, 1931. Pain in back and left hip which had been an early and persistent complaint had almost subsided and there was "definite evidence of increased calcification in spine and pelvis" at this time. On May 15, patient returned to work putting in a 7 hr. day standing at the drawing board for 2½ hours. General improvement continued and the patient was presented, in person, September, 1931, together with the original roentgenograms and

clinical laboratory findings, to the Bloodgood Bone Clinic in Baltimore by his physician and Drs. Merritt, Lindsay and Lattman, as a case of myeloma.

A practically unanimous opinion favoring this diagnosis was obtained at that Clinic.

Progress Notes and Summary. The patient has resumed his former occupation with no interruptions on account of his former disability. Roentgenograms show increasing calcification of all cystic areas and no new areas have developed except in the skull where some were noted in a recent examination.

The most striking improvement followed deep roentgen therapy to the cervical region and treatments have been resumed over this region on the theory that the case is one of widespread cystic bone disease resulting from hyperparathyroidism. The urine is now negative for Bence-Jones bodies. The patient was again studied at the Bloodgood Clinic, September 21, 1932, as a case of parathyroidism and this opinion was sustained by a large majority.

A careful check-up on the original roentgenograms made in June, 1930, shows a third lumbar vertebra which has the appearance of having exploded. This together with other bony lesions observed then and later plus the records of similar cases in the literature warrants a change in diagnosis from myeloma to parathyroidism.*

CASE III. Female, white, single, aged fifty-three, was referred by Dr. Bullock of Washington, D. C., for roentgen examination of the left leg. Family history unessential.

Personal History. Patient has experienced increasing intermittent pain and lameness in left leg for past year or more. Patient is a well-nourished female who appears to be about sixty years of age. General examination negative except for slight lameness of left leg and a saber-shaped deformity. Special examinations negative. Roentgen examination shows the characteristic findings of osteitis deformans in the left tibia only.

Treatment. Roentgen therapy over parathyroids: 5 ma., 135 kv., 10-inch distance, 6 minutes, 5 mm. Al filter, to each side of neck, every three weeks, as an experimental procedure. Following second treatment a roentgeno-

* This patient died June 9, 1933, of multiple myeloma, verified at autopsy, but no parathyroid glands were found.

gram of the affected bone showed a definite change. There was an appreciable diminution in the calcium content of the tibia; the cortices were much less dense and there was an actual decrease in the diameter of the bone. The patient has less pain and claims to "feel better." The patient was returned for roentgen study three times in as many days to confirm the above findings.

Four treatments in all were given and a sub-

sequent roentgen study showed no essential change in the bone since previous examination.

Relief of pain following irradiation of the parathyroid region has been reported in two other well established cases of osteitis deformans observed by Dr. Lattman and myself and Drs. Coe and Otell, not here recorded because comprehensive data are not available at this time.



FOREIGN BODY REMOVAL WITH THE AID OF THE DOUBLE PLANE ROENTGENOSCOPE*

By WILLIS F. MANGES, M.D.
PHILADELPHIA, PENNSYLVANIA

SO FAR as I know, Grier,¹ of Pittsburgh, was the first to assemble a double plane roentgenoscopic apparatus. I remember seeing it in his office many years ago, and some years before I did the same thing.

My first work of roentgenoscopy in two planes was accomplished by moving the vertical roentgenoscopic apparatus to the side of the horizontal roentgenoscopic table. This was a very dangerous scheme because there were many assistants or spectators in the room and they were prone to approach the exposed high tension wires. As soon as possible we changed to apparatus which had the roentgen tube inside the high tension transformer case, so that the element of danger from electric shock was entirely eliminated.

At present we have one transformer mounted on a movable carriage under the table. Another similar transformer is mounted on a framework so that it can be raised or lowered and it is at one side of the table. Each transformer has a separate filament control and milliammeter, also a foot switch. The apparatus

is shifted to one end of the table or the other, according to the side on which the foreign body is located, in order that the side containing the foreign body may be nearest the screen. I use a 6×8 inch screen with a wooden handle, and a magnifying glass, so that I have the screen in one hand and the magnifying glass in the other. The table was formerly a horizontal roentgenoscopic table. It has a canvas top and underneath the table on a framework there are tracks running lengthwise on which the transformer platform is moved, so that this transformer under the table can be moved the entire length of the table. We have extra wooden tops that are supported above this table on crosspieces. They bring the patient up to the proper height for the bronchoscopist. The ends are beveled in such a way that the patient's arms can be thrown downward and toward the head so that they are out of the line of vision for lateral roentgenoscopy. We have one of these for children and one for adults. The transformer that is mounted at the side of the table is on casters so that it

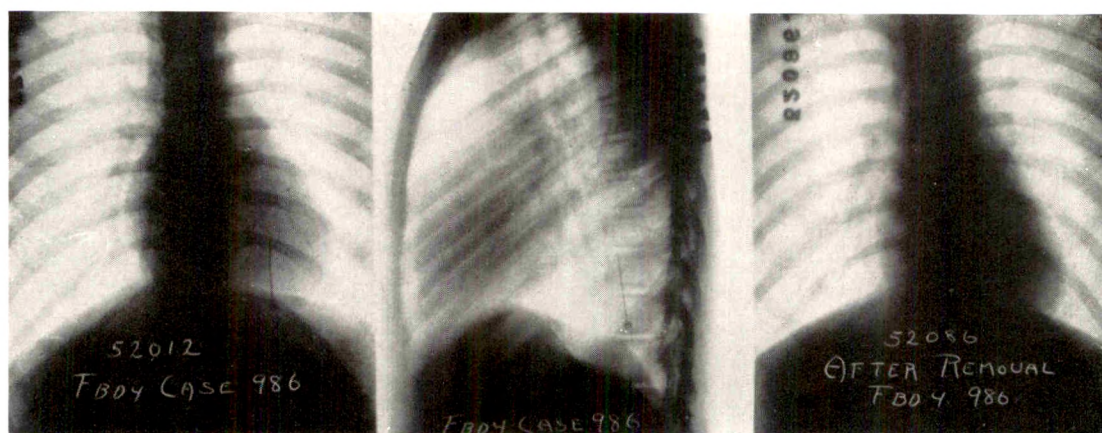


FIG. 1. The pin is beyond direct vision through the bronchoscope. Note that in neither view is it in line with the lower lobe bronchus.

* Read at the Radio'logical Conference, Philadelphia, Jan. 27-28, 1933.

can be moved to any point in the room. One can now buy better-looking and more flexible apparatus. Our outfit has the advantage of having proved successful in hundreds of cases, with less than 1 per cent of failure or mortality.

been the safety pin, but we have had numbers of pins, needles, nails, tacks, screws, toys, hairpins, bullets, staples, jewelry, dental foreign bodies, bird shot, etc.

The indications for use of the double

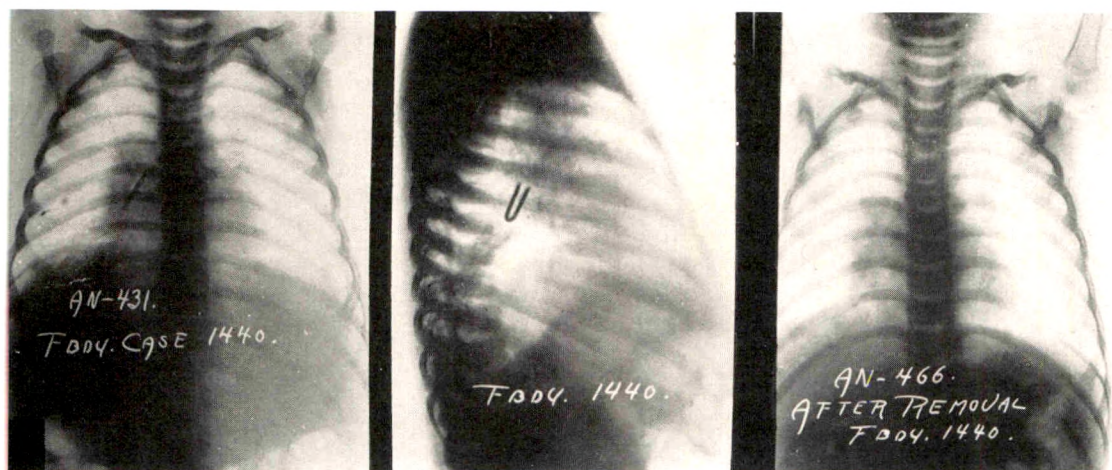


FIG. 2. The staple is surrounded by a dense process.

Jackson² has emphasized the dangers of attempting to use roentgenoscopy in one plane only, in the removal of foreign bodies in the bronchi.

The operation with a double plane roentgenoscope might also be dangerous if the bronchoscopist were inexperienced, and especially if both the bronchoscopist and roentgenologist were inexperienced. Our extremely low percentage of failures, and only one death in literally hundreds of cases, seem to prove the safety and value of the method under favorable conditions and in competent hands.

The vast majority of cases at the Jefferson Hospital have been foreign bodies in the bronchi, the esophagus, or the stomach, but we have also had cases of foreign body in the brain, quite a number of non-magnetic foreign bodies in the eye, in the neck, in lung tissue extrabronchial, in the abdominal viscera, and in soft parts generally throughout the body.

The foreign bodies have been of the greatest variety. The most common has

plane roentgenoscope are: (1) all opaque foreign bodies in the air passages below the larynx having sharp points (Fig. 1), irregular shape, cutting edges, projections, or length; (2) all opaque foreign bodies that lie beyond direct bronchoscopic vision, whether they are in anterior, posterior or lateral branches of the bronchi, or whether at too great depth for the bronchoscope to reach (Fig. 2); (3) all opaque foreign bodies that are associated with a pathological process that interferes with bronchoscopic vision; (4) foreign bodies that are extrabronchial (Figs. 3 and 4) but in close relation to fairly large bronchi, and that are not too large to be brought into the bronchoscope or into very close relation to the end of the bronchoscope; (5) in the esophagus, all open safety pins (Fig. 5); (6) all opaque, large, irregularly shaped foreign bodies below the level of the suprasternal notch; (7) all opaque foreign bodies associated with stricture of the esophagus or any pointed or long (Fig. 6) foreign body that lodges

and remains in the esophagus; (8) in the stomach, as a rule open safety pins of medium or large size should be removed; (9) opaque foreign bodies having length, such as nails, hairpins, etc.; (10) in any case where the patient has a pyloric or duodenal lesion, or any foreign body that remains in the stomach for more than a few days; (11) any foreign body that is apt to present an emergency if not promptly removed. For instance, Dr. Farrell helped in one case where a capsule of radium was removed from the stomach in this manner; (12) in

the eye, any non-magnetic opaque foreign body in the eyeball or orbit that can be seen roentgenoscopically. It is extremely important that accurate localization with the Sweet Localizer or its equivalent be made before operation for removal of a foreign body in the eye is attempted; (13) in all other parts of the body where there is any opaque foreign body that for any reason demands removal. The simplest case sometimes turns out to be the hardest. Of this group, the most important one is the needle. It is commonly found in the palms

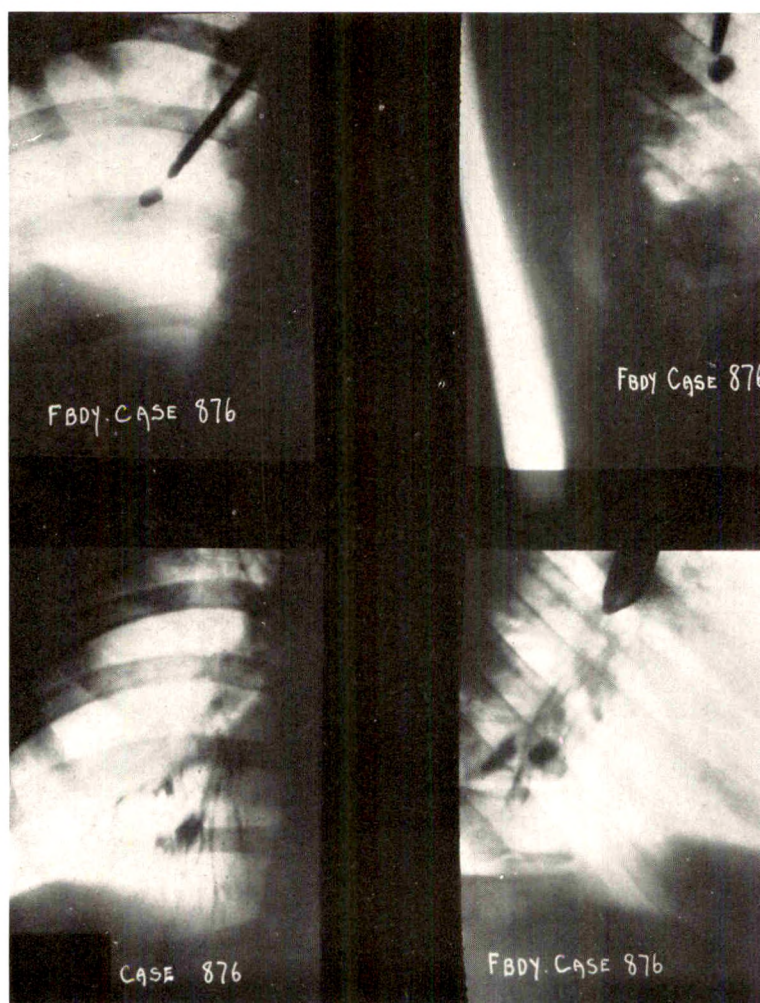


FIG. 3. The .22 caliber bullet is an extrabronchial foreign body. Note the relation of forceps to the foreign body above and of bismuth-insufflated bronchi to foreign body below. These exposures were made at the time of the first bronchoscopy. At the second operation, a special bronchoscopic forceps was made to penetrate the nearest small bronchus and then the bullet was grasped and removed through the bronchoscope.

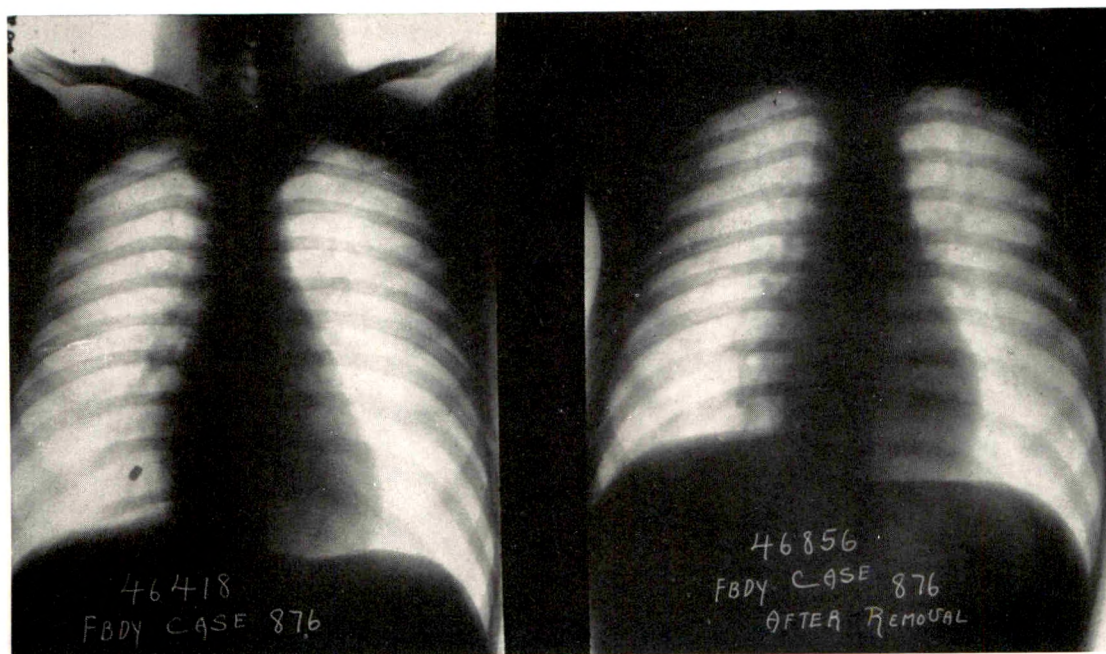


FIG. 4. Shows the chest before and after removal of the bullet.

of the hands or in the feet. It is especially important to use the double plane roentgenoscope for removal of foreign bodies in soft tissues or hollow viscera when it is at all possible for the foreign body to be moved by surgical manipulation. The sense of touch cannot be relied upon to locate a foreign body when it is imbedded in soft tissue.

DUTY AND FUNCTION OF THE ROENTGENOLOGIST

The roentgenologist must assume responsibility for the amount of roentgen-ray exposure to the patient or the assistants. While I have had no accidents, I have often been filled with anxiety for a period of two weeks. One cannot measure the amount of radiation given during such an operation, but one can expose very small areas, divide the exposure as equally as possible in the two planes, and at every possible opportunity turn off the current—for instance, while the bronchoscopist is using the aspirator or changing forceps or shifting the patient to a better position or while he is trying to get a bronchoscopic view.

In bronchoscopic and esophagoscopic cases, one must be careful to avoid exposing the head or hands of the assistant holding the patient's head, also the nurse or assistant holding the shoulders of the patient. In surgical cases the surgeon and his assistant may get direct exposure. Eye cases particularly present risk to the operating surgeon when the lateral tube is used because his forceps are necessarily short and small so that his hand has to be close to the part to be viewed roentgenoscopically. One must be extremely careful to work with a very small diaphragm opening and be on the lookout for screen shadows of extraneous objects. I frequently call for light, to see that everyone is in a safe position and also tell each surgical assistant or nurse to keep the hands and arms out of line of the rays.

The tube under the table is about 24 inches from the patient. The rays are filtered through oil, 1 mm. aluminum, a canvas table top and 1 inch of wood. The ray from the lateral tube is filtered only by oil and aluminum and the tube may be from 18 to 24 inches from the patient, so that

allowance must be made in using the lateral tube.

An assistant keeps check on the time—tells me when fifteen, thirty, forty or fifty minutes are up. I use no more current in the tube than is necessary to enable me to

able experience. It is much better to interrupt the operation than to produce a roentgen-ray lesion, unless some unusual emergency exists. I have often asked the bronchoscopist or surgeon to stop because I feared I was approaching the danger line.

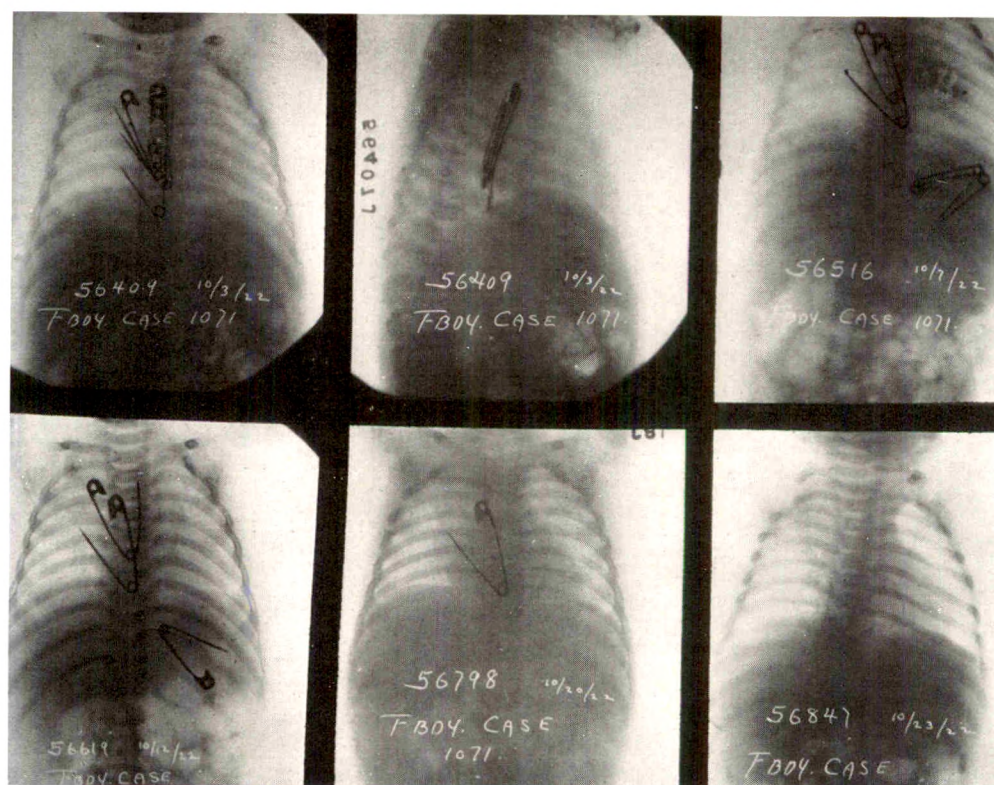


FIG. 5. Four large open safety pins in the esophagus of a baby nine months old were more or less entangled. At the first operation Dr. Jackson pushed the lower two into the stomach. They passed without harm to the baby. At the second operation the uppermost pin was taken out through the mouth. The remaining one was also removed by mouth at the third operation.

see the foreign body and instruments. Depending upon the amount of current, and the character of the operation, as, for instance, whether I can interrupt the exposure frequently and shift from one tube to the other, we have worked as long as forty minutes, and in exceptional cases even one hour. However, this must not be taken to mean that I have exposed the same area of any one patient for as much as one hour. I would also warn one not to try to operate in this way for as much as one hour or even forty minutes until he has had consider-

In such cases we wait for two weeks, if circumstances permit, before doing a second operation. A few patients have had two, three, four or more such sessions before the foreign body was finally obtained (Fig. 7). In two instances only have we been unsuccessful in removing the foreign body entirely in bronchoscopic cases. One was an open safety pin high up in the left upper lobe bronchus. We succeeded in getting the keeper branch but not the point branch. The pin was corroded and broke near the spring. The other was a needle, an extra-

bronchial foreign body, in the right middle lobe. It was extremely difficult to grasp and finally broke into three pieces, two of which were not recovered. The patient lived at a

sure; my hands, therefore, are never exposed to direct radiation. I use a well-protected screen, 6×8 inches, with a long wooden handle. This I keep in my left

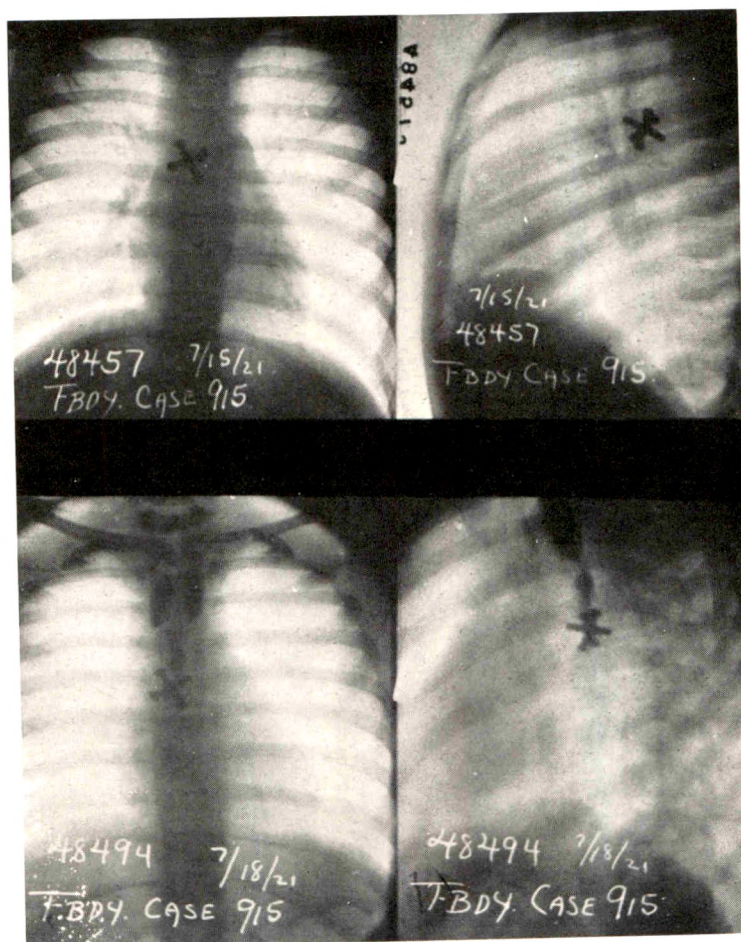


FIG. 6. Note that the jackstone is below a rather narrow stricture and is producing complete obstruction of esophagus. An attempt had been made by another surgeon to push the jackstone into the stomach. This produced definite injury to the esophagus. This foreign body was removed by the method described here and later the strictures were dilated to a satisfactory diameter. The foreign body was not visible to the bronchoscopist.

distance, went home, and did not return.

The roentgenologist also has a definite responsibility with regard to his own safety. I may be open to criticism when I say that in real difficult cases where frequent and rapid shifts from anteroposterior to lateral views are necessary, I have been wearing only surgical rubber gloves and not lead rubber. But I am extremely careful to have the screen cover the entire area of expo-

sure; my hands, therefore, are never exposed to direct radiation. I use a well-protected screen, 6×8 inches, with a long wooden handle. This I keep in my left hand while in my right hand I hold a magnifying glass, also with a wooden handle. The advantages of the small screen are that it does not tire the operator to hold it a considerable length of time; it is possible to bring it in the closest possible relation with the part under observation; it can be shifted easily and quickly from one position to the other; it is not in the way of the bronchoscopist or surgeon as a larger screen

might be, and it makes one keep the area of exposure small, which is best for many obvious reasons.

Preparation of the eyes for roentgenoscopy is to be taken very seriously. A grad-

room, where, when not actually working, I keep my eyes shut or covered by my hands to keep out the light. I am certain that care in preparation has served me well in many difficult cases.

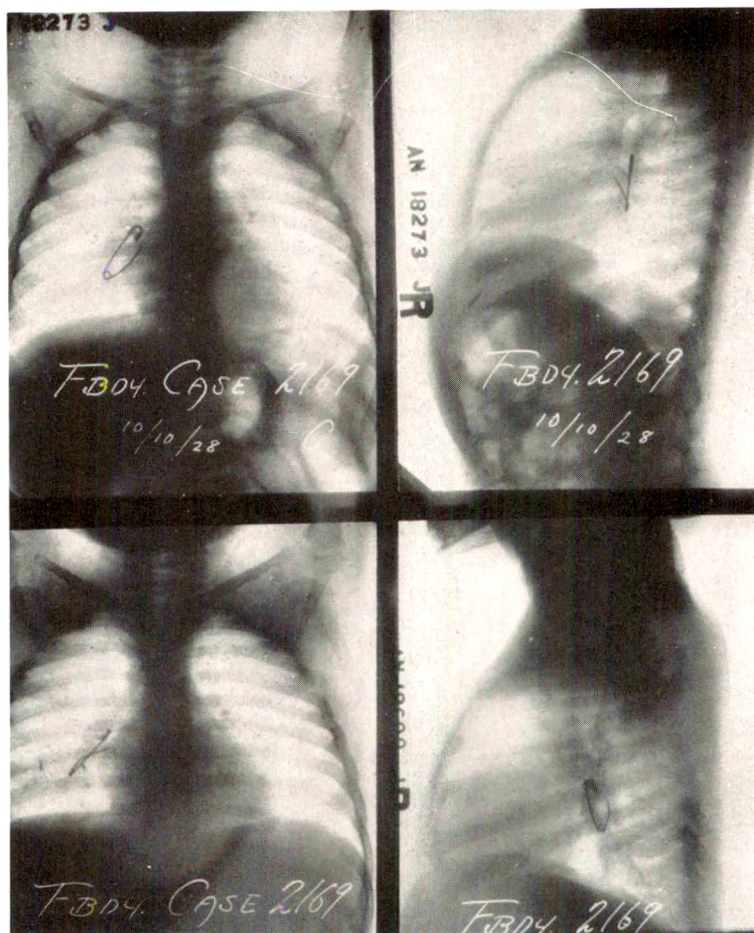


FIG. 7. Above, note bent point branch in close relation to heart. Below, note keeper branch is now close to heart and point branch is posterior. This change in position is all that was accomplished at the first operation. The pin was removed safely at a second operation.

ual and long-continued effort to get perfect accommodation in darkness is preferable to going from bright light to total darkness. I wear dark glasses while doing other work, for as much as an hour, if possible, before such an operation, and then just before cases in which the foreign body is small or deeply situated, I go from one degree of darkness to another to complete darkness until I go into the dimly lighted operating

Preliminary roentgen diagnosis and localization must be quite complete in order that as many as possible of the operative problems may be anticipated. This includes preliminary roentgenoscopic as well as roentgenographic localization, and especially when the foreign body is lacking in density and is, therefore, seen with difficulty roentgenoscopically. A good magnifying glass is a very important aid.

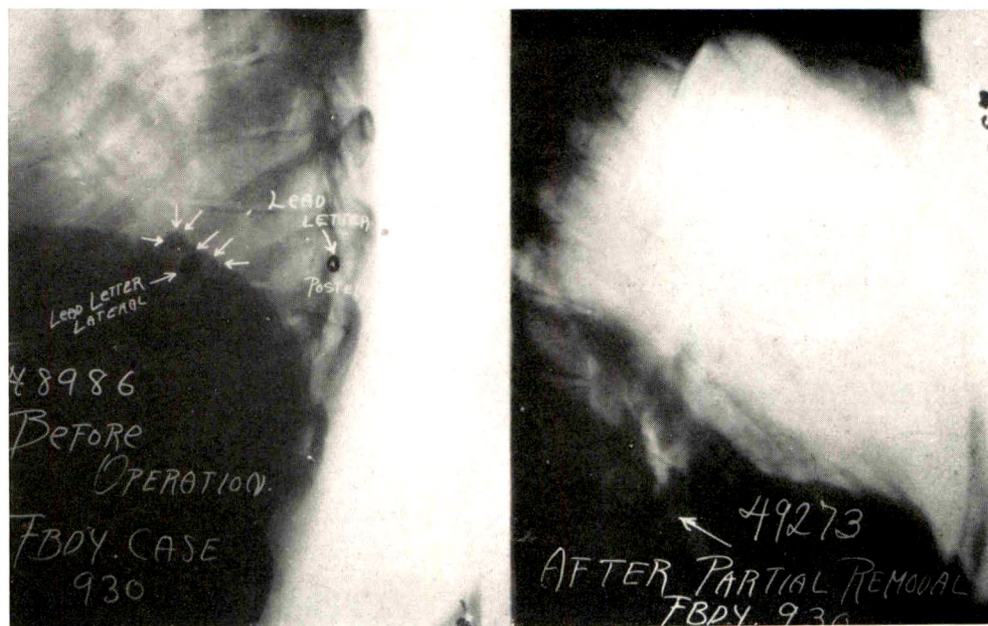


FIG. 8. Note lead letter "O" on posterior aspect and one on lateral aspect. Other arrows point to a faint shadow of a shawl pin.

One should not attempt to assist in removing a foreign body unless he has a definite knowledge that he can recognize the shadow of it in this way. I have occasionally used a method very similar to that described by Pancoast and Pendergrass³—that is, I have from previous roentgenograms in the anteroposterior and lateral views in as near the bronchoscopic position as possible determined at about what point on the surface of the body the central ray would emerge, and there I would place one lead letter "O" on the anterior or posterior surface and one at a similar point on the lateral aspect of the chest (Fig. 8); and then with the patient on the double plane roentgenoscopic apparatus make films to show the relation of the foreign body shadow to the path of the central ray and to the lead letter "O." Then, at the time of operation, it was easy to see the lead letters and to tell the approximate location of the foreign body. This method is especially valuable when there is a deeply situated localized infection that should be drained, whether the foreign body is removed or not, because the roentgenoscope

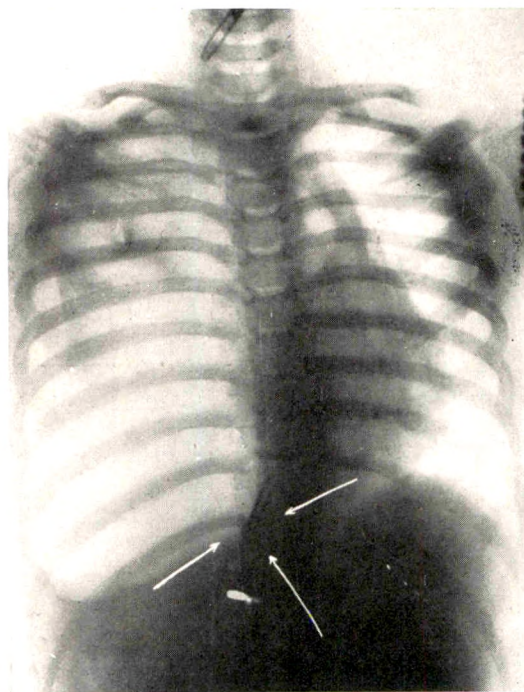


FIG. 9. A staple is in a completely compressed left lower lobe. There is also an extensive pyopneumothorax. The staple was removed surgically through an opening in the chest wall. The surgeon's forceps were directed into the collapsed lung by means of the double plane roentgenoscope.

at least guides the instruments to the area of infection. After bronchoscopic drainage or perhaps repeated drainages of such areas of infection the foreign body may at times become easily visible.

Whenever possible, a duplicate of the foreign body should be obtained so that the bronchoscopist or surgeon may make tests and select his instruments to the best ad-

because the upper end of the cavity was the most dependent portion when the patient was in the recumbent posture. This problem was solved by placing a large magnet (Figs. 10 and 11) over the chest wall and drawing it downward, making the bullet go to the lower end of the cavity where it was easily possible to guide the forceps to a satisfac-

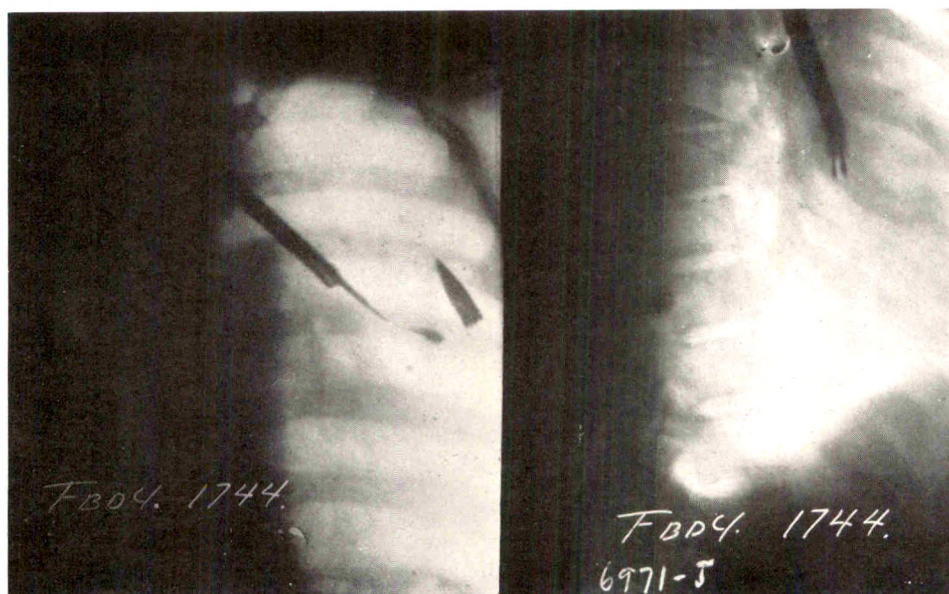


FIG. 10. A steel-jacketed bullet lies in the uppermost part of a cavity when patient is in a recumbent posture. Note that it is at too high a position for the forceps to grasp. At the second operation a large magnet was applied over the chest wall and by this means the bullet was drawn downward to a position where it was possible to have the forceps reach it. The bullet was then successfully removed with the bronchoscope.

vantage. Complications, such as penetration of the wall of the esophagus or bronchus by a pointed foreign body, the presence of an enlarged thymus, collapse of lung tissue, pneumothorax, exudate in the surrounding lung, etc., should be considered with the utmost care. For example, one foreign body (Fig. 9) in an area of collapsed lung may be removed via the bronchoscope while another may require surgical intervention. In one case a steel-jacketed bullet was found in a cavity in the left lung. It was easily possible for Dr. Jackson to get forceps through the bronchoscope into the cavity, but the bullet remained just out of the grasp of the forceps

tory grasp of the bullet, whereupon it was successfully extracted.

I believe that Hickey⁴ was the first to use a magnet to influence the position of a metallic foreign body so that it could be successfully grasped.

The operative problems sometimes change with the utmost suddenness, and many of our successes have been due to our ability—particularly because of the ability of Dr. Jackson and Dr. Clerf, with whom nearly all of my work has been done on bronchial, esophageal and gastric cases—to shift the plan of attack and take advantage of some favorable change in the operative problem. Again, success has come from the prompt,

courageous, but still careful act of instrumentation in the face of a crisis, such as suspended respiration. The roentgenologist must be prepared for sudden changes and keep the operator informed of the behavior of the foreign body.

It is extremely important that the bronchoscopist or surgeon and roentgenologist should understand each other with regard to the directions that are given during the

keeper," "You have hold of the spring," "You have the extreme point in the forceps," "One point of the staple is outside the bronchoscope," etc. These are expressions commonly used and are understood.

Generally speaking, the forceps used for grasping the foreign body should be selected with the idea in mind of visibility as it involves the foreign body as well as the forceps. If the foreign body is small or

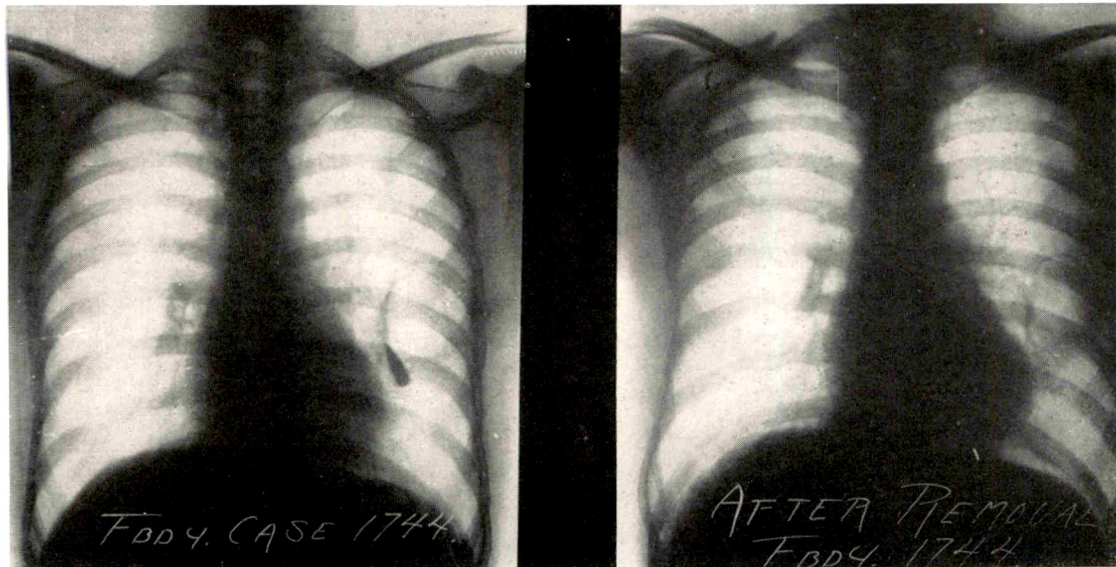


FIG. 11. Shows the chest before and immediately after removal of the bullet. Note that bullet is in dependent portion of cavity in erect posture.

operation. It should be remembered that the patient is not under an anesthetic and can hear everything that is said, so that, while it is necessary to speak frankly and with positiveness, yet one should avoid displaying a feeling of apprehension that might cause the patient unnecessary fear, or interfere with his cooperation to the fullest extent. In the case of young children this, of course, does not apply to the same extent. Simple terms are best in giving directions. I say "Go deeper," "Withdraw," "Go to left," "Go to right," "Go forward," "Go back," "Open your forceps laterally," "Open anteroposteriorly," "Now close forceps," "Hold," "Without opening forceps go left, right, back, forward, deeper, withdraw slightly," "You have hold of the

slender, then the forceps blades should be slender, because with a large metallic shadow of forceps it is more difficult to recognize the delicate shadow of the foreign body than if the forceps image is also small. Many of the successes at the Jefferson Hospital have been due to the fact that there has always been a large variety of scopes and instruments to choose from, and often these are changed during the progress of the operation.

The roentgenologist should acquaint himself with the mechanical problems from the bronchoscopist's or surgeon's point of view, so that he may be in a position to offer suggestions during the operation.

In bronchial cases one usually sees the roentgenoscopic images best in the dorso-

ventral view, while in esophageal cases he may see the shadows of foreign body and instrument to better advantage in the lateral projection. However that may be, it is best to have the operator open his forceps

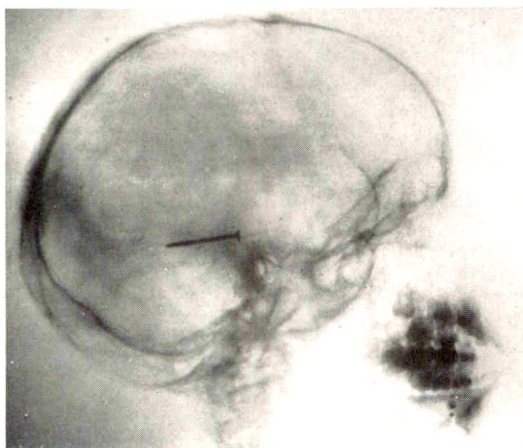


FIG. 12. A lateral view showing a nail deeply situated in the brain. It went in through the eyeball from an air rifle.

blades so one sees the space between them in the direction that gives the best view of the foreign body. This applies particularly to slender-pointed foreign bodies, such as the pin group. This is not a fixed rule, for a forceps opening in another direction and properly applied pressure may be just the thing needed to bring the point of a pin out of a lateral or oblique bronchial branch. When the foreign body is large and irregular, then the forceps opening must suit the conditions that prevail.

If the forceps grasp is not satisfactory for withdrawal, the operator sometimes tries to shift his instrument to a more favorable hold without letting go entirely, but, until the hold is safe, he is not told to withdraw it. In several instances of gastric foreign bodies, I have been able by palpation on the external abdominal wall either to bring a foreign body into relation with the forceps or to shift it in such a way as to improve the grasp of the forceps.

When the foreign bodies are in the trachea, bronchi, esophagus or stomach, one is working in a natural passage and cutting

instruments are not used, so that one can work almost entirely by roentgenoscopy and in the dark. But, when directing the surgeon to a foreign body, the operation must be done partly with light so that he can proceed to greater depth in the tissues without destroying vital or important anatomical structures; and then, with a blunt instrument in the depth of the wound, the relation between this instrument and the foreign body is determined roentgenoscopically. If the instrument is almost in contact and there are no surgical contraindications (Figs. 12 and 13), the surgeon can be directed to grasp a bit of tissue in the end of the forceps and then, in the light, proceed again in the proper direction surgically. In this manner the foreign body is finally reached without much trauma to the surrounding tissues and with no more cutting than necessary. Here, again, the problems vary a great deal and one must be prepared for these variations to occur during the operation. I should perhaps say that all the surgeons with whom I have

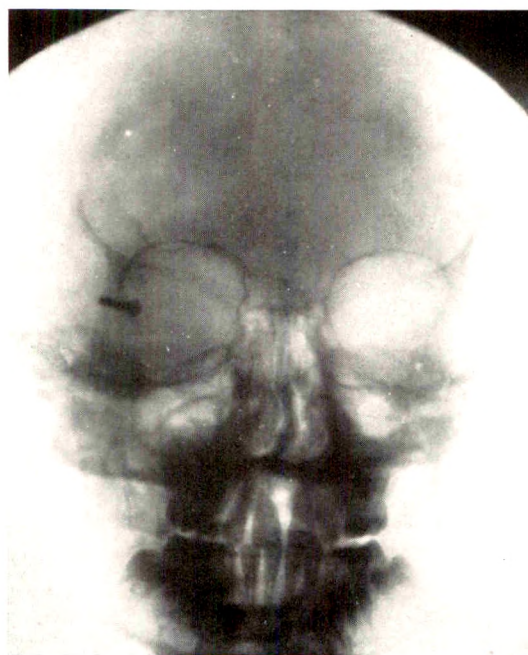


FIG. 13. Frontal view of nail. This was successfully removed through a small trephine opening on the double plane roentgenoscopic table.

worked have the greatest desire to put their fingers into the wound to try to feel the foreign body. This is a great mistake because it so often happens that the foreign body can be moved from one place to another with very little effort. This is espe-

posterior direction. We were fortunate enough, however, to get it with the aid of the lateral tube alone. All of these eye cases have been done with Dr. George H. Cross⁵ doing the surgical operative work, and, thanks to his great skill, we have now had

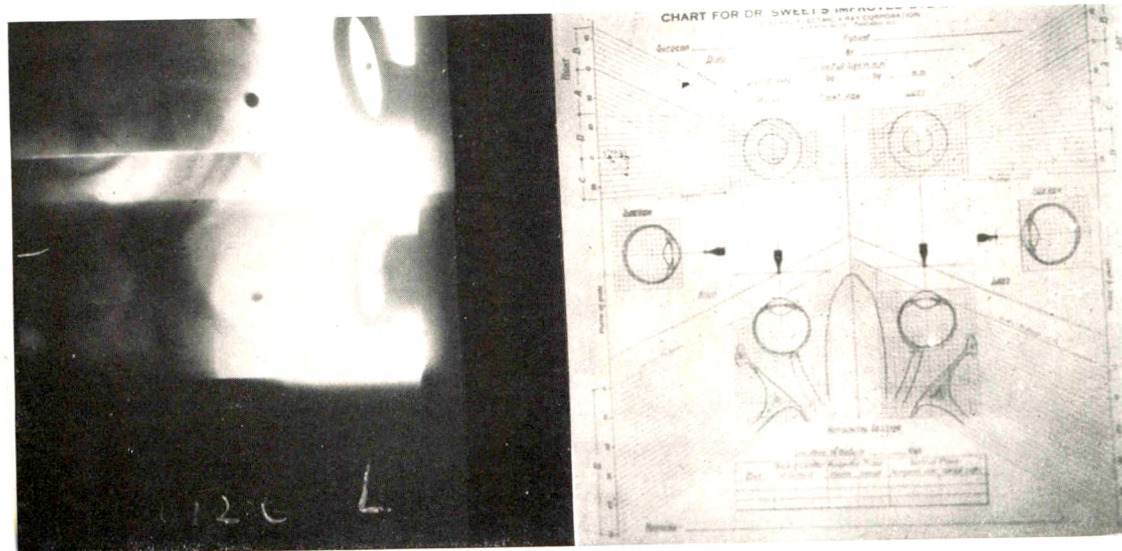


FIG. 14. Shows a bird shot in the posterior chamber of the left eye. Note location as shown on localization chart. Successfully removed.

cially true of needles or foreign bodies in the intestines.

The operation on the eye is the most delicate of all in some respects (Fig. 14). In the first place, it is difficult for the patient to hold still, because, while the external coat of the eyeball is under the effect of cocaine, no anesthetic is used inside the eye, and it is therefore painful if the forceps come in contact with the retina. In the second place, the foreign body is in a semi-liquid medium, the vitreous, and for that reason the forceps grasp must be very accurately directed or the foreign body will go to one side or escape from the end of the forceps. In the third place, in some cases it is extremely difficult to see the foreign body shadow in the anteroposterior direction. In two of our cases, there were multiple shot in the tissues around the eye and in the eyelids, but with only one shot in the eye in each case. In one of these, the shot was so small that I could not see it in the antero-

12 cases of bird shot and one case of a piece of copper inside the eyeball all successfully removed and no failures.

In one case it was considered advisable to remove the shot as soon as possible, and we accepted the localization of another roentgenologist who had plotted the location of the shot to be inside the eyeball. At operation it was possible to determine roentgenoscopically that the forceps could not come into actual contact with the shot. There was a space of about 2 or 3 mm. between the two. Later the eyeball was removed and the shot was found to have penetrated the posterior wall of the eyeball and lay just on the surface of it.

Again, one should never attempt to aid in removal of a foreign body from any portion or organ of the body that he cannot see roentgenoscopically with certainty, and he should avoid being impatient or in a hurry.

The work that I have done in this way has been done always under the most favor-

able conditions, so far as my part was concerned. Especially was this true in the bronchial, esophageal and gastric cases, because from the first I was under the mas-

terly control and influence of Dr. Jackson, and then his very skillful successor, Dr. Clerf. The successes I have shared in were their successes.

REFERENCES

1. GRIER, G. W. Fluoroscopic bronchoscopy. *AM. J. ROENTGENOL.*, 1916, 3, 123-125.
2. JACKSON, CHEVALIER. *Bronchoscopy and Esophagoscopy*. Second edition. W. B. Saunders Co., 1927, p. 224.
3. PANCOAST, H. K., and PENDERGRASS, E. P. Localization of foreign bodies in the lung by roentgen examination. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 27, 225-233.
4. HICKEY, P. M. Foreign bodies in the oesophagus and the lower air passages. *J. Mich. M. Soc.*, 1910, 1-3.
5. CROSS, GEORGE H. Removal of nonmagnetic foreign bodies from the vitreous. *Pennsylvania M. J.*, 1931, 34, 478-481.



THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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E D I T O R I A L

ROENTGENOLOGY OF THE GASTROINTESTINAL TRACT

WHEN the printing house of J. Oporinus issued Vesalius' famous "Fabrica" in 1543 the work was so complete and detailed in every feature that no real additional anatomical information was added till the introduction of the microscope almost two hundred years later, and it was not until 1833 that Beaumont published his experiments on Alexis St. Martin which for many years were the only fundamental observations made on the action and function of the stomach and the part it plays in digestion. It awaited the introduction of the roentgen ray into the field of medicine before any further progress was made beyond these original experiments of Beaumont's other than such information as might be gained by the introduction of tubes into the mouth, stomach and duodenum from which the chemical features of digestion were gradually elucidated. However, the movements of the alimentary canal could only be determined indirectly by the introduction of balloons and other devices to indicate the pressure changes, or by inference from experiments on animals under anesthesia. While these experiments added considerable fundamental knowledge, the information gained could not be wholly translated into human terms and those of us who have to do with the daily routine of roentgenological problems scarcely appreciate the fact that the information upon which we base our diagnosis as regards gastrointestinal conditions has, for the most part, been laboriously and patiently built up during the last twenty-five years.

Dr. A. E. Barclay, in his book on "The Digestive Tract" recently published,* has

called attention to the fact that roentgenology has been so successful in the diagnosis of pathological conditions that there is a tendency to overlook its applications to anatomy and to physiology. The early workers were faced with the fact that the orthodox anatomy and physiology of the alimentary tract were hopelessly at variance with what they saw. By degrees they worked out the normal as far as they could and today the roentgenologist turns to roentgenological works and not to textbooks of physiology or anatomy for help in interpretation, because these textbooks are based upon studies made in the post-mortem room or in the dissecting laboratory, and what the roentgenologist sees is the living anatomy and living physiology which have not as yet found their way into textbooks.

It is a bit unfortunate, Barclay says, that the utilitarian demands of the time necessitated the use of the roentgen ray in the diagnosis of pathological conditions and that while we have built up as a result of these studies an enormous amount of information which deals with the pathological, there still remains a great deal of work to be done in the realm of the use of the roentgen ray in the study of the more purely physiological problems. These studies are necessitated by the fact that the roentgenologist is dealing with the living functioning human being. Not only do mental influences affect the form and position of the stomach but many mechanical factors are responsible for the change in the shape of the stomach such as the posture of the subject and the tonic action of the intrinsic muscles, the movements of the diaphragm, the distention of the organ by the bulk of the food as well as by the weight of the

* Barclay, Alfred E. *The Digestive Tract: A Radiological Study of its Anatomy, Physiology, and Pathology*. Cambridge University Press, London, 1933.

food, though to a small extent only, and the stomach is also influenced by pressure from other organs. Nature, he states, has no set patterns either in form or in function; she varies her methods ceaselessly and the more we see of the inner workings of her mechanics and chemistry, the more we realize that they constitute a kaleidoscope of balanced form and function, the mutations of which are utterly bewildering to those who attempt to describe and tabulate them. It is therefore highly artificial to separate form from function or anatomy from physiology because in life these three melt imperceptibly into one another and to the roentgenologist who studies living conditions there is no artificial dividing line. What he sees is a living factor; there are no sharp divisions or walled-off departments; he sees anatomy, physiology and pathology as one whole. The form, the shape of the stomach is anatomy, yet a slight deficiency of tonic action, a physiological change, may alter the picture completely, while the presence of a contraction may be pathological or merely a physiological response to some stimulus remote from the stomach itself.

Dr. Barclay, in his splendid book, calls attention to things of such fundamental importance as the movements and excursions of the diaphragm and the various levels of the diaphragm at inspiration, expiration and at rest. He was one of the early workers in this field of physiology and he stresses the essential difference between the study of the living in regard to the position of the diaphragm as compared with the formal textbook discussions on these subjects. He emphasizes the influence of the movements of the diaphragm on the gastric function and calls particular attention to the shape and disposition of the abdominal contents. He also stresses a fact well known to roentgenologists that there is considerable misunderstanding of the so-called "gastroptotic" or "dropped" stomach, emphasizing that the shape of the stomach is easily altered by pressure of intra-abdominal structures or even by gas

in the intestine. Not only is attention directed to the extreme mobility of the stomach but, as a result of some ingenious studies, he has pointed out this feature of other intra-abdominal organs as well as of the kidneys, and from these composite studies he has shown how utterly fallacious is the conception of fixity conveyed to the student by descriptions based on observations on the dead body, and that fixation of the viscera in definite positions in relation to the abdominal wall and to each other is foreign to nature.

One of the many excellent chapters in Dr. Barclay's book is devoted to a study of the normal mechanism of swallowing, the author himself having made many fundamental observations along this line. He calls attention to the extraordinary fact that so little research seems to have been carried out on the mechanism of swallowing, an act which is of such supreme importance to a person's well-being, and that gravity which has always played such an important part in any discussion of the act of swallowing is in reality a negligible quality. He has found that the process of swallowing as seen roentgenologically consists in three fundamental changes, namely, the whole larynx rises; suddenly the pharyngeal space is obliterated, just for a fraction of a second, before the food slips over the back of the tongue; the pharyngeal space usually appears again and into it comes the swallowed opaque mass. It appears to be just thrown back into this cavity by the action of the tongue, and it seems to shoot as though through space, at a tremendous speed, as if the cavity had no walls. The bolus, as it travels, gives the impression of being sucked rather than pushed down and negative pressure plays an important part in the mechanism of swallowing. Obviously, swallowing is not the simple, almost peristaltic, movement that it was once considered.

The introduction of the opaque meal has completely disproved the previously taught ideas of the stomach as an organ consisting of two parts, the upper acting as a hopper in which the food was stored and the lower

as a mill in which it was thoroughly mixed and churned until a given degree of acidity was produced, causing the pylorus to open allowing the food to pass. The stomach is now seen as a living tubular muscle, a sensitive organ, perhaps, as Barclay says, the most sensitive muscular organ in the whole body. Its shape depends on its tone and the tone may alter from moment to moment in response to a great variety of physical and psychical stimuli; it is a "fluid" organ which changes its shape not only in response to tone but in response to its peristalsis, the gastric peristalsis varying enormously, as all roentgenologists have had occasion to observe, not only with the individual but from time to time in the same individual. The forceful churning waves that were described in the early observations are not the usual type of peristaltic movement seen in man under normal conditions. Peristalsis in the normal subject is not a forcible movement and Barclay aptly describes it as suggesting "the waves that running shorewards help the sea-drift on its way, rather than the breakers beating upon the rocks." He agrees with Alvarez that the forces which bring about, modify and control peristalsis must be looked for mainly within the walls of the gut itself. It is a fact that at present little is known about the exact method of conduction of the wave of gastric contraction, and one of the fundamentals of digestion, namely, the control of the pyloric sphincter, is as yet almost entirely unknown. Certain it is that the opening of the pylorus does not depend on the acidity or alkalinity of the food.

Barclay, in conformity with most observers, has found it extremely difficult thus far to study satisfactorily the small intestine and he believes that the study of the movement of the food or opaque meal through the small intestine will come when more adequate technique, such as efficient cinematographic roentgen-ray studies, are possible.

From his study of the large bowel Barclay is convinced that the slow peristalsis which was formerly described in the large

bowel does not take place and he agrees with Holzkecht, Case, and others, that the movement of the material in the large bowel is a "mass movement," that this mass movement is dependent on the formation of a definite constriction, a *point d'appui*, and in the majority of cases this *point d'appui* occurs near the hepatic flexure. The colon distal to the constriction loses its haustral segmentation and the colonic contents seem to back up to the point of constriction as if forming a mass ready to be propelled onwards when the mass movement takes place. The whole column on the distal side of the *point d'appui* or constriction is swept along. The *point d'appui* has also been observed in the splenic end of the transverse colon. Dr. Barclay is convinced that the keystone to the efficiency of this mass movement of the large intestine lies in the competence of the *point d'appui*; in addition to the mass movement changes are from time to time seen in the shape of the haustral segments of the large intestine, especially the transverse and descending colon. Barclay points out the fact that the problem of the passage of the food through the large intestine is full of difficulty, not only because the observations are few and far between in spite of the vast number of patients examined, but also because the whole conception of mass movement is revolutionary and alien to the traditional line of thought, and he says it is regrettable that we have been brought up on an armchair conception of what takes place, for unconsciously we attempt to make our observations fit in with our preconceived notions and the whole subject of the physiology of the colon seems to be in chaos as there is no satisfactory basic knowledge. Most of the literature on the colon, which is voluminous, has to do with its diseases, and because our fundamental physiological knowledge of the colon is so limited we derive little profit from either the clinical or roentgenological study of the large intestine, except in a very few definite and specified conditions such as neoplasm, diverticulosis and poly-

posis, and the knowledge of so important a subject as constipation is still extremely confused. Barclay raises the question as to whether constipation, per se, is a pathological condition or one of disordered physiology. His own observations have led him to believe that there are three types of constipation: in an absence of mass movement, inertia of the colon; stagnation in the cecum, and stagnation in the rectum. Of these colonic inertia is the most frequent, and if the mass movement is not effective there is nothing but the comparatively feeble movement of the cecum to propel the feces onward; that is, the mass in the cecum itself has to act as the *point d'appui*. The part played by the cecum in the movements in the large bowel is not clear but Barclay's deductions have led him to believe that this portion of the large gut has a separate mechanism or peristalsis for mixing the contents and feeding them into the ascending colon preparatory to the mass movement. Rectal stagnation, Barclay believes, is in reality a fault of defecation often acquired through neglect of the call to stool, rather than a true constipation. But certain pathological conditions of the colon, namely, neoplasms proximal to the rectum, often

give a ballooning of the rectum which would lead to the inference that rectal stagnation may have an additional cause such as some disturbance in the propagation of the peristaltic wave through disturbance in the nervous mechanism.

It is difficult for the roentgenologist of today to appreciate the laborious amount of work and the infinite details which the early investigators carried on in order to perfect the diagnostic signs which are used with such facility and ease today. But in the study of the pathological conditions it must be understood that in "radiology as in every branch of medicine the diagnosis of the abnormal can only be based on a thorough recognition of the normal and an appreciation of the limits of normality." Dr. Barclay in his discussion of the normal and its variable picture has admirably prepared the ground for a point of departure and further study into the less understood realms of the physiology of the gastrointestinal tract. There remains, as he says, much to be done in this field of endeavor, and the stimulus of this timely book should incite many workers to a further inquiry by roentgenological means into the normal physiology of the gastrointestinal tract.



SOCIETY PROCEEDINGS CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.

Annual Meeting: Pittsburgh, Pa., Sept. 25-28, 1934.

AMERICAN COLLEGE OF RADIOLOGY

Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.

Annual meeting: Cleveland, 1934.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.

Annual meeting: Cleveland, Ohio, June 11-15, 1934.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.

Annual meeting: 1934, to be announced.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY

Secretary, Dr. R. T. Taylor, Los Angeles, Calif.

Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.

Annual meeting: Richmond, Va., November, 1933.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. G. W. Cramp, 521 President St., Brooklyn, N. Y.

Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.

Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. R. G. Willy, 1138 N. Leavitt.

Meets second Thursday of each month October to May inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. Otto Glasser, Cleveland Clinic.

Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital.

Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.

Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill.

Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. N. Collins, Indianapolis, Ind.

Annual meeting each February 22 in Indianapolis.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Kalamazoo, Mich., November, 1933.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.

Meets first Friday in October, December, February and April. Place of meeting designated by the president.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.

Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.

Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY

Secretary, Dr. Major Fleming, Rocky Mount, N.C.

Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. H. S. Bull, 604 Masonic Temple, Auburn, N. Y.

Three meetings a year—January, May and November.

PACIFIC ROENTGEN CLUB

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Meets annually, during meeting of California Medical Association

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Reiley, Clearfield, Penna.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. Karl Kornblum, Graduate Hospital.

Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. W. W. Fray, Strong Memorial Hospital.

Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB

Secretary, Dr. W. K. Mueller, University Club Bldg.

Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston.

Meets at time and place of South Carolina State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY

Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.

Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

UNIVERSITY OF WISCONSIN ROENTGEN CLUB

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis.

Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 P. M.

VIRGINIA ROENTGEN RAY CLUB

Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.

Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA

Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P. M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

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RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.

Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

INDIAN RADIOLOGICAL ASSOCIATION

Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta. Meets annually in January, and at such places and times as the Council may appoint.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY

Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgian).

Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE

Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.

Secretary for German language, Dr. Scheurer, Molzgasse, Biel.

Meets annually in different cities.

SOCIÉTÉ FRANÇAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE

of August and September, 12 Rue de Seine, Paris. ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA

Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)

Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.

Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY

Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

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Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banul Maracine 30, Bucarest, Rumania.

Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin.

Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY.

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.

Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. B. Krynski, 11 Zielna St.

Meets once a month except in the summer time.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN

Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY

Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK

Secretary, Dr. H. Scheuermann, Copenhagen.

Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND

Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY

Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION

c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY

A CORRECTION

To the Editor:

In my paper on "The Pineal Body" published in the August, 1933, issue of the Journal, the following statement is made on page 148: "Schüller stated that the normal position of the pineal shadow in lateral roentgenograms of the skull was 1 cm. above a line joining the external auditory meatus and the lower border of the orbit, and 1 cm. posterior to the vertical plane, through the external auditory meatus."

This should be changed to read: "... 4.5 to 5 cm. above a line joining the external auditory meatus," etc.

J. H. VASTINE

MINNESOTA RADIOLOGICAL
SOCIETY

The Minnesota Radiological Society held its Fall meeting at the St. Paul Athletic Club, St. Paul, Minnesota, November 11, 1933. The following program was presented: "Osteochondritis Juvenilis Deformans (Perthes' Disease); Report of Cases." W. L. Burnap, M.D., Fergus Falls; "Observations from a Clinical Tour." M. A. Shillington, M.D., St. Paul; "Pneumonia in Young Infants Associated with the

Aspiration of Various Oils." Kano Ikeda, M.D., St. Paul; "The Roentgen Diagnosis of Placenta Praevia." Walter H. Ude, M.D., Minneapolis; "The Improvement of Chest Roentgenography." R. B. Wilsey, M.A., Rochester, N.Y.; "Motion Picture Demonstrating Manufacture of X-Ray Film." L. A. Carlson, St. Paul; "The American Registry of Radiological Technicians." George M. Landau, M.D., Chicago. Address: "The Value of Ventriculography and Encephalography to the Brain Surgeon" by Alfred W. Adson, M.D., Rochester, Minnesota.

UNIVERSITY OF WISCONSIN
ROENTGEN CLUB

The University of Wisconsin Roentgen Club held its first meeting on Thursday, October 26, 1933. The following topics were discussed: "Lesions of the Cardio-esophageal Region" (Dr. L. W. Paul); "Extra-gastrointestinal Masses" (Dr. L. W. Paul), and "Radiation Therapy in Mediastinal Tumors" (Dr. E. A. Pohle).

Dr. C. R. Bardeen, Dean of the Medical School is Chairman of the Club and Dr. E. A. Pohle, Secretary. Meetings will be held on the last Thursday of each month from October to April.



DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., 105 Rutledge Ave., Charleston, S. C.

"CHIP-IN" METHOD OF TIME-TEMPERATURE TANK PROCESSING

By S. W. DONALDSON, M.D.

St. Joseph's Mercy Hospital
ANN ARBOR, MICHIGAN

SINCE the time-temperature tank development (5 min. at 65° F.) has been so successfully and universally employed in the x-ray processing room, an efficient method of estimating the rate of developer exhaustion has been needed.

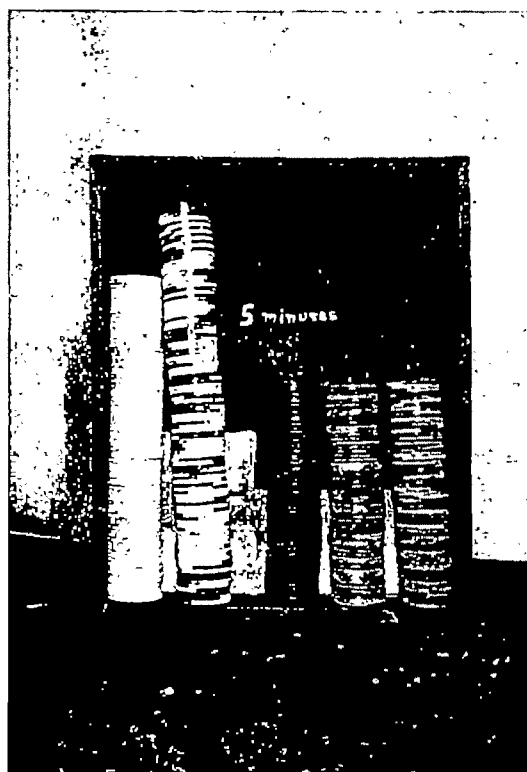


FIG. 1.

An inexpensive and reasonably accurate method of recording and compensating for the degree of exhaustion of a developing solution for roentgen films has been successfully employed at St. Joseph's Mercy Hospital, Ann Arbor, Michigan, for over a

year. The system was originally devised here and as far as we know is the only one now in use.

In our laboratory, the amount of work and number of films exposed vary seasonally. It is therefore difficult to set a definite day to make up new developing solution. Various known methods for determining the strength of solutions were tried from time to time but discontinued for one reason or another. For a considerable period of time before installing our present system, the films developed were tallied in order to obtain a general idea as to the number of each size of film used before solutions were discarded. Ten gallon tanks were filled and fresh solution was added from time to time in order to maintain the original required volume. One large dry film will take up and carry over to the wash water, unless well drained, about an ounce of solution.

It was found that 10 gallons of solution would handle:

100.....	14" X 17" films
120.....	8" X 10" films
60.....	10" X 12" films
60.....	11" X 14" films
60.....	6½" X 8½" films

and 300 regular size dental films or the equivalent in square inches of emulsified surface before complete exhaustion occurred or stain appeared, or approximately forty films per gallon. A simple counting system was then tried out and it has so far proved to be entirely successful.

For our counters 400 poker chips were obtained. In order to secure colors other

than the conventional red, white and blue; some blue and white chips were half submerged in red, quick-drying lacquer. This method made it possible for us to obtain five different sets of chips, as follows:

- 100 white chips, each representing a 14"×17" film
- 120 half-red, half-white chips, each representing an 8"×10" film
- 60 red chips, each representing a 10"×12" film
- 60 blue chips, each representing a 11"×14" film
- 60 half-red, half-blue chips, representing a 6½"×8½" film

The chips were then stacked in a rack and placed near the film dryer. Each time a film is hung to dry, a poker chip of the color designating that size is removed from the stack and dropped through an opening into a container. A slot in the cover of an empty No. 4 can in which developing powders are packed serves our purpose well.

Sometimes it becomes necessary to use combinations of chips when all of one size is expended—that is—three 8"×10" or two 10"×12" or one 11"×14" and one 8"×10" are approximately equal to one 14"×17" or other combinations to obtain an approximately equal number of square inches of surface. Dental films are "chipped-in" with a white chip when a gross package is

opened as it is easier than to wait until they are all developed.

As the height of the stacks of chips grows less, we increase the developing time, which was originally five minutes at 65° F. When all the chips are used, the solutions are considered completely exhausted and new solutions are then made. The chips are then sorted and restacked in the respective troughs ready to be used for the next batch of developer.

The adjustment in time of development is easily controlled by having the back of the trough in which the various colored chips are stacked, divided by colors into three zones. The upper zone, or 60 per cent of the entire height, of the stack is labeled "five minutes," the middle, or 25 per cent, labeled "six minutes"; and, the lower part, or remaining 15 per cent, is the seven minute zone. When a new color level is reached in one stack, combinations are used to bring the other stacks down to the corresponding color level before the time is increased.

We have found that this method is exceedingly practical, surprisingly accurate and that it takes less time and trouble than any method we have tried.



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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

ROVIDA, FRANCESCO. Della malattia di Schüller-Christian. (Schüller-Christian's disease.) *Radiol. med.*, July, 1932, 19, 667-691.

A case of Schüller-Christian's disease, or hypophyseal dysostosis, is described in a child twenty-three months of age. The mother began to notice arrest of development at the age of eight months. In the spring of 1929 a soft swelling developed in the left temporo-parietal region and gradually increased in size. About six months later the child began to have a blackish discharge from the nose and ear. The Wassermann reaction was negative. After a reactivating injection of calomel it was positive for two antigens and negative for two. When the child was brought to the roentgen institute for examination he showed two swellings in the temporo-parietal regions, one the size of a walnut and the other the size of a large pigeon's egg, and other smaller ones on the frontal bone. The roentgen picture showed many clear areas in the bones of the skull, giving it a "geographic" appearance. The bones of the face were normal but there were areas of rarefaction in the humeri and one in the left wing of the ilium.

The case was evidently one of Schüller-Christian's disease. Differential diagnosis from neoplasm was made by histological examination of a piece of excised tissue. From February 11 to March 15, 1930, a series of roentgen treatments amounting to 700 r was given over the left temporo-parietal region and 345 r on the right side, in fractional doses of 70 r on alternate days; 160 kv. 3 ma., filtered with 0.5 mm. copper and 3 mm. aluminum, fields 10×10, focus-skin distance 36 cm. The child improved greatly and later the humeri and iliac bones were irradiated.

The author discusses the various theories in regard to the origin of the disease and concludes that the primary cause is not hypophyseal, though it shows the symptoms of lesions of the tuber cinereum and hypophysis. The areas of rarefaction in the bones are always present, but the other symptoms of the

disease, diabetes insipidus, exophthalmos and retardation of growth may be absent or develop late. Spontaneous cure may occur, particularly if the disease develops late in life.

The disease is really a xanthomatosis caused by disturbances of fat metabolism, and the hypophyseal involvement is secondary. The best treatment is roentgen irradiation. Hard rays are generally used with a dose varying from a third to a half of an erythema dose. A moderate dose should be given at first and the results followed up by roentgen examination, the later doses being adapted to the findings.—*Audrey G. Morgan.*

AGATI, DINO. Tuberculosis infiltrante della volta cranica. (Infiltrating tuberculosis of the vault of the cranium.) *Radiol. med.*, May, 1932, 19, 476-482.

The circumscribed, perforating form of chronic tuberculosis of the skull is more common than the progressive infiltrating form. The author describes a case of the latter in a patient sixteen years of age in which the roentgen picture of the skull was not decisive enough for a definite diagnosis. In this case the differential diagnosis had to be made from hypophyseal dysostosis, myeloma or chloroma rather than from syphilis, echinococcus or neoplasm, and the differentiation from these conditions is discussed. Diagnosis was possible only from careful study of both the clinical and roentgen signs. The frontal bones showed zones of transparency. These clear zones had indistinct and slightly dentate outlines without any density around the margins indicating bone or periosteal reaction; in their centers were small shadows probably caused by small sequestra. The sella turcica was normal in size and shape.—*Audrey G. Morgan.*

GEYMAN, MILTON J., and CLARK, DANIEL M. The roentgen demonstration of petrositis. *Acta radiol.*, May 15, 1932, 13, 125-133.

There has been no adequate standardized technique for the roentgen demonstration of suppuration in the petrous portion of the temporal bone. As in the mastoid process, the cell development of the petrous portion varies greatly within normal limits and it is necessary to

have a thorough understanding of its cell development in order to be able to interpret the roentgenograms correctly. As a general rule, the petrous pyramid shows a cell development parallel with that of the mastoid; that is, if the mastoid is sclerotic the petrous pyramid will be and if the mastoid is pneumatized the petrous bone will be also. Infection nearly always occurs in the pneumatized type of bone. There seem to be two chief paths by which infection spreads from the tympanum to the tip of the petrous bone—the antrum-epitympanic route and the hypotympanic route.

The authors show that the positions used in the study of the petrous bone for 8th nerve tumors are not at all satisfactory for the demonstration of petrositis. The vertico-mental and fronto-occipital positions give the best results. In the case of infection by the hypotympanic route the infection may not show in the fronto-occipital view, but infections along the antrum-epitympanic route may be shown in either position. As the pathological process is similar to that in the mastoid the roentgen picture is similar. At first there is simply a general haziness and displacement of air as compared with the normal side; later there may be destruction of cell outline and localized abscess formation and finally healing with sclerosis throughout the involved area.

A diagnosis of petrositis should never be made without clinical symptoms. Asymmetrical mastoid development is very frequent and the same thing probably occurs in the petrous pyramids. One pyramid may be sclerotic and the other pneumatized. When sclerotic pyramids are demonstrated on both sides petrositis is not probable. Bilateral petrositis has never been reported.—*Audrey G. Morgan.*

RENANDER, AXEL. Das Röntgenbild bei otogenen tiefen Felsenbein Affektionen. Apizitis. Gradenigos syndrom. (The roentgen picture in deep otogenous diseases of the petrous bone. Apicitis. Gradenigo's syndrome.) *Acta radiol.*, May 15, 1932, 13, 165-177.

The author describes 5 cases of Gradenigo's syndrome which he examined roentgenologically. All of them showed changes in the roentgen picture, which in 4 of the cases were very marked, in the other one less so. The roentgen picture generally showed a diffuse thinning of the bone at the tip of the pyramid, interruptions of continuity of the outline of the cortex

and defects in the tip of the pyramid. The defects at the apex were probably caused by halisteresis.

Special care has to be exercised in taking pictures of this region. The author has found Stenvers' position the best as it gives a picture of the apex in natural proportion without any disturbance from superposition of other bone shadows. The disadvantage of this position is that it is hard to carry out accurately and requires a little practice. A primary diaphragm should be used and stereoroentgenograms taken.—*Audrey G. Morgan.*

MATTEUCCI, EUGENIO. Sul metodo Vogt. (Vogt's method.) *Radiol. med.*, May, 1932, 19, 482-485.

In 1921 Vogt described a method of demonstrating foreign bodies in the eye which are too small or of too low an atomic weight to be shown by the ordinary methods of roentgen examination. These bodies are often hidden by the shadow of the bones in the ordinary methods of examination but by this method no bone shadows are taken. A small film is held at the inner angle of the eye parallel to the inner wall of the orbit and the roentgenogram taken from the temporal side or the film is held horizontally parallel to the floor of the orbit and the roentgenogram taken from above. A small fishhook is hooked into the conjunctiva under local anesthesia to act as a guiding point to localize the foreign body. A tube with a punctate focus is used and the rays, filtered through 1 mm. aluminum, pass through a cylindrical limiter 30 cm. long and 6 cm. in diameter. The focus-skin distance is 60 cm., intensity 35 ma., tension 40 kv.

The author describes 2 cases in which small bodies in the anterior part of the eye were located in this way and the patients saved enucleation. One of the foreign bodies was removed with a magnet and the other extracted with small forceps.—*Audrey G. Morgan.*

SOLOMON, H. C., and EPSTEIN, S. H. Encephalography under narcosis produced by nonvolatile anesthetics. *J. Am. M. Ass.*, May 21, 1932, 98, 1794-1796.

Although encephalography is largely replacing ventriculography, the extreme headache, nausea, vomiting, diaphoresis and even collapse, often met with render it an unpleasant and tedious proceeding. Morphine and scopolamine fail to completely control symptoms;

ether is attended with the hazard of pulmonary complications and produces an undesirable rise in blood pressure. Non-volatile anesthetics such as pentobarbital sodium, amytal, and avertin have been used with much success. The authors use the first named and have produced a deep anesthesia, obviating symptoms and producing no harmful effects. Headache may occur five or six hours later but is mild and easily controlled. The authors describe a special chair stretcher with movable back rest, shoulder straps and a head sling. This permits easy handling of the anesthetized patient with rotation of the head in all positions to obtain necessary encephalograms.—*E. W. Hall.*

DUNLAP, HAROLD F. Metastatic malignant tumors of the brain. *Ann. Int. Med.*, April, 1932, 5, 1274-1288.

This is a clinical, statistical and pathological survey of 95 patients with a diagnosis of metastatic malignant tumor of the brain. The average age was $47\frac{1}{2}$ years; 49 males and 46 females. In cases in which the primary lesion should have been readily recognized, the average duration prior to the onset of cerebral symptoms was 21 to 31.5 months. The average length of life from the time of examination after onset of cerebral symptoms was $3\frac{1}{2}$ months.

The presenting symptoms were directly referable to the cerebral lesion in 68 cases, to the primary lesion in 15, while 12 cases presented symptoms referable to both lesions. The most frequent cerebral symptoms were headache, vomiting, often of a projectile nature, disturbances of vision and of speech, vertigo and transient aphasia. Mental disturbances appear to be one of the outstanding features as they were observed in 57 per cent of the series, varying from sluggishness to confusion and even stupor in the more advanced cases. The presence and severity of mental symptoms appeared to bear a possible relationship to the presence and severity of the encephalitic changes. Those symptoms associated with metastatic tumor of the brain seemed to be more marked than those associated with primary brain tumor. Choked disk was found in 40 per cent of 84 cases so examined; 9 cases presented perimetric visual field defects and 3 showed optic atrophy.

Study of the clinical localization of the cerebral tumors failed to disclose any region of predilection for the development of metastasis in the brain. Detailed neurological study was car-

ried out in 16 cases and the site of the cerebral lesion correctly diagnosed in 7 of these. In the remaining 9 cases either localizing signs were absent or dissemination of the signs led to incorrect diagnosis of an inflammatory lesion. Metastatic malignant tumor of the brain was diagnosed in 6 cases, there being an obvious primary tumor elsewhere than the brain, recognizable metastasis or a history of previous operation for a malignant tumor situated outside of the central nervous system in all. A diagnosis of primary tumor of the brain was made in 5 cases, none of which presented either symptoms or signs referable to a primary lesion elsewhere.

Roentgenologic study failed to reveal the presence of many of the growths encountered. A diagnosis of primary or metastatic malignant growth of the lung was made in 37 per cent of the 78 cases examined. Metastasis or other pathologic change was reported in 21 per cent of the 63 cases in which roentgen examination of the skull had been made.

The lung, breast and kidney accounted for 58.6 per cent of the primary lesions in those cases where the site could be determined. Metastasis was widespread throughout the body in general, the lung being involved in 83 per cent of those cases in which necropsy was performed.

All cases presenting clinical evidence of a tumor of the brain should be studied carefully for presence of primary malignant tumor outside of the central nervous system. Roentgenograms of the thorax and skull, for evidence of metastasis, should be made as a routine in such cases.—*W. R. Brooksher, Jr.*

SCHEUERMANN, H. The roentgenological picture of the normal and the pathologic sella turcica. *Acta radiol.*, 1932, 13, 404-432.

The author has collected and examined roentgenograms of the skulls of 391 patients showing normal conditions and 55 with diseases of the brain showing roentgen changes. Specimens of the sella turcica from 100 patients with normal conditions and 41 with brain affections have been examined roentgenologically, compared, sawed through and then compared again. The technique of roentgen examination of the skull is discussed and the necessity for absolutely exact and uniform projection emphasized. The normal anatomy of the sella turcica is described.

The roentgen picture of the sella is described

in detail, giving measurements and form and descriptions of the sphenoidal sinus, the anterior clinoid processes, the dorsum sellae and the posterior clinoid processes. The dorsum sellae may normally be so thin as to be invisible in the roentgenogram of the living subject. A thin dorsum sellae is the most frequent form. The tissue may, even under normal conditions, be so plastic that the dorsum sellae can be moved forward and backward with the hand. The large air space in the spongy dorsum sellae is described and the characteristics of the dura mater and its calcareous content discussed. There may be a deficiency of calcareous material in the dorsum sellae at any age; it is not caused by senile osteoporosis.

The position of the head in certain brain tumors and the basal angle are discussed. Differences in the width of the latter are not important.

The causes of primary and secondary enlargement of the sella are discussed. Dilatation of the third ventricle for a considerable time may cause enlargement of the sella; dilatation of the ventricle for a short time does not have any effect.

In all the cases examined, the autopsy findings agreed with the roentgen findings. The roentgenologist should be very reserved in expressing an opinion as to whether pathological changes in the sella are primary or secondary.—*Audrey G. Morgan.*

NECK AND CHEST

DELHERM, THOYER-ROZAT, P., CODET, P.-H., and FISCHOLD, H. La kymographie. (Kymography.) *Presse méd.*, April 2, 1932, 40, 515-517.

The kymography of the heart introduced by Stumpf is very simple, representing a method analogous to serial roentgenography for the study of the duodenal bulb. It consists in the use of a lead diaphragm having parallel slits of 0.5 mm. width at intervals of 11.5 mm. from each other which is interposed between the subject and the film during the time of exposure. To record the movements one may displace either the film or the diaphragm for a distance corresponding to a single interval between the two slits. The two procedures lead to somewhat different results. In the first (displacement of the film) the motion of a limited number of points of the heart silhouette is recorded, the image thus taking the aspect of

steps of a scale. In the second (displacement of the diaphragm) the motion of the entire heart silhouette is registered, the contours assuming a finely dentated aspect on the films. The two methods have an equal value, except that the first permits the reconstruction of the movements by a very simple procedure with the aid of the kymoscope. The second is used chiefly in the current practice.

The kymogram represents a succession of sinuosities and notches replacing the usual contours of the heart and aorta. By studying the number, amplitude, peristalsis, density, form, etc., of these sinuosities and notches, one may arrive at a definite conclusion concerning the changes of various sections of the heart. The authors briefly describe the appearance in normal and in pathologic conditions, such as valvular lesions, affections of the pericardium and of the great vessel.

The conclusion is reached that kymography, although still in the stage of development, represents certain indisputable advantages. Thus the clinician is able to obtain the record of the diastole and systole on the same film, he may precisely determine the location of point G, he may differentiate between the left auricle, pulmonary artery and aorta and finally he may establish a differential diagnosis of certain mediastinal opacities.—*T. Leucutia.*

BOGART, FRANKLIN B. X-ray examination of the heart in left auricular enlargement. *South. M. J.*, June, 1932, 25, 596-602.

Roentgen examination of the heart in left auricular enlargement by roentgenoscopy with either the teleroentgenogram or orthodiagram gives information that is of value in diagnosis and prognosis. The methods of examination are detailed with the normal findings briefly reviewed. Left ventricular enlargement produces changes on the contour of the heart, bronchi and esophagus. The use of lipiodol and barium for the visualization of the left bronchus and the esophagus respectively is discussed. The article is illustrated with films and diagrams.—*W. R. Brooksher, Jr.*

BLITCH, C. G., MORGAN, HUGH J., and HILLSTROM, H. T. Early (subclinical) syphilitic aortitis; an evaluation of radiographic diagnostic methods. *South. M. J.*, July, 1932, 25, 709-711.

If aortitis could be detected before the development of irreversible changes therapeutic

results would be markedly improved. Such "subclinical" aortitis might be arrested and the development of the late, fatal manifestations prevented. The present study was confined to individuals with uncomplicated chronic syphilis without clinical evidence of aortitis, but in whom the incidence of subclinical aortitis is doubtless high. In such patients any deviation from the normal aortic roentgen findings would be significant and would constitute presumptive evidence of aortitis. There were 30 such cases available for study, all males, with an age range of thirty-five to fifty-five years. Roentgenoscopic and film studies in all projections and the ingestion of thick barium paste to determine the relationship of the esophagus, heart and aorta, were carried out in all cases. The usual cardiac measurements were made. The diameter of the aortic arch was measured at the point where the aorta indents the visualized esophagus. The studies were entirely negative in that no changes were found which are not encountered in perfectly normal individuals of the same age group.—*W. R. Brooksher, Jr.*

LUPACCIOLU, GIOVANNI. Due casi di aneurisma dell'arteria anonima. (Two cases of aneurysm of the innominate artery.) *Radiol. med.*, Feb., 1932, 19, 122-130.

Aneurysm of the innominate artery is quite rare. The author describes 2 cases with illustrative roentgenograms. The first was in a man of thirty-eight in whom a diagnosis of asthma was made at first because of expiratory dyspnea. He complained of constant dizziness. The Wassermann and Meinicke reactions were negative. Roentgen examination showed a shadow that extended from the mediastinum over the whole upper median third of the right lung field. In the oblique projection it was dissociated from the shadow of the large vessels and showed expansive pulsation. On the basis of this picture a diagnosis of aneurysm of the innominate artery was made; it was confirmed by death of the patient from rupture of the aneurysm.

The second case was in a man of thirty-nine with a history of syphilis. On the basis of the shadow in the mediastinum a diagnosis of tumor of the mediastinum was made and roentgen treatment given. This did no good at all but the patient improved considerably on antisyphilitic treatment. This patient also complained of dizziness; he had a feeling of constriction in the throat and pain irradiating from the neck to the right arm; he spoke in a low voice

and had a feeling of formication in the right hand which was somewhat cyanotic. From the failure of roentgen therapy it was decided that the diagnosis was wrong and the patient was sent for another roentgen examination with a probable diagnosis of aneurysm of the aorta. The picture was very much like that in the preceding case, except that the dense shadow did not pulsate. A diagnosis of aneurysm of the innominate was made and in this case was also confirmed later by death of the patient from rupture of the aneurysm.

Patients with aneurysm of the innominate almost always complain of dizziness. This in association with a shadow in the right upper half of the mediastinum should suggest aneurysm of the innominate. The shadow does not necessarily pulsate. Cardarelli says the dizziness and fainting fits are due to cerebral aneurysm from bits of clot detached from a thrombosis but the author thinks it more probable that the sac brings about disturbances in the circulation of the internal carotid which cause these symptoms.—*Audrey G. Morgan.*

BEUTEL, A. Oesophagusvarizen. (Varices of the esophagus.) *Acta radiol.*, 1932, 13, 527-532.

Two cases of varices of the esophagus are described and illustrated with roentgenograms. Both the patients showed the clinical picture of cirrhosis of the liver. The diagnosis of varices of the esophagus was made from the roentgen picture and confirmed in both cases by esophagoscopy and in one by autopsy also.

Normally the relief of the esophagus is characterized by delicate longitudinal folds. These disappear in varices. The esophagus is abnormally wide and there are clear bands, which may run longitudinally or transversely, bordered by narrow stripes of contrast medium. The barium sticks to the dilated vessels and remains in the esophagus an abnormally long time. Differential diagnosis from malignant tumor is sometimes difficult. Normal distensibility of the wall of the esophagus does not always exclude tumor. The roentgen diagnosis of varices of the esophagus is of great value in explaining obscure cases of hematemesis.—*Audrey G. Morgan.*

LAURELL, HUGO. The origin of the Zenker pouch of the pharynx. *Acta radiol.*, 1932, 13, 599-602.

In a previous article in this journal the author discussed the origin of Zenker's pouch and

persists. Conversely, in no case was the cap seen before collapse and not visible in the pneumothorax films. The type of shadow which persists after collapse occurs within the arc of the first rib and in the posterolateral quadrant of the apical cupola. Its direction is forward and outward. The visceral margin is sharply defined and the density is homogeneous. The shadow never crosses the first rib. It ranges from 2 to 4 mm. in width and from 1.5 to 2 cm. in length. This shadow is thought by the author not to be due to thickened pleura but probably to Sibson's fascia which is a fibrous aponeurosis passing from the anterior surface of the transverse process of the 7th cervical vertebra to the inner margin of the 1st rib in front of the subclavian groove. Whatever the source of the shadow, it is stressed that it has no pathologic significance.

Apical pulmonary scars, on the other hand, are never sharply defined. Microscopically they consist of pleural and subpleural fibroses in which tubercles may or may not be frankly present. All such deposits are presumed to be of tuberculous origin. Any apical linear shadow that does not clearly conform to the position and characters of the so-called apical cap is probably of this nature. In 1,083 stereoscopic roentgenograms tuberculous scars were found in 27 per cent and apical caps in 34 per cent.

A further type of linear apical shadow is that seen beneath the 3rd (occasionally 2nd) posterior rib practically always on the left side only. A vertical continuation often passes to the aortic arch medially. This shadow is homogeneous. It is presumed to be due to the subclavian artery.—*G. R. Miller.*

MARAGLIANO, GIULIO. Sulla frequenza dell'infiltrato precoce. (The frequency of early infiltration.) *Radiol. med.*, June, 1932, 19, 578-601.

The author discusses Assmann's theory of early infiltration as the first manifestation of adult tuberculosis as opposed to the old theory of the apical origin of the disease. In the examination of 3,200 roentgenograms he found the classical picture of early infiltration without involvement of the apices in only 15 cases. When rather less strict criteria were used the number of cases rose to 500. He concludes therefore that early infiltration is relatively rare and early infiltration without involvement of the apices still rarer. Assmann and his school would argue that these early infiltrations are transitory and

therefore would not be revealed by roentgen examination unless it were made just at the right time. The author describes 6 cases illustrated with roentgenograms which show that they may persist for some months or a year. While this is not an extremely long time it is longer than the advocates of the early infiltration theory give to the demonstration of their theory. They base their demonstration on roentgenograms showing integrity of the apices and the rest of the lung and roentgenograms taken shortly afterward showing infiltration. They think that this proves that the infiltration is really the first manifestation of the reinfection. But this presupposes that once apical lesions have developed they persist throughout life. This is not true. The author describes a case in which roentgenograms taken in November, 1929, and April, 1930, showed the apices normal. A roentgenogram in August, 1930, showed subclavicular foci on both sides with the apices still clear. But an old roentgenogram from September, 1929, showed a small lesion in the left apex. Besides lesions of the apex are not always shown in roentgenograms.

The author concludes that the truth of the early infiltration theory is not proved. Assmann and his school say that the prognosis in these early infiltration cases is very bad if diagnosis is not made early and treatment given. The fear of overlooking such serious lesions may have caused roentgenologists to detect more early infiltrations than really existed.—*Audrey G. Morgan.*

TORELLI, GASTONE. Ulteriori considerazioni sulla genesi del pneumotorace apaco o pneumotorace ad immagine paradossale. (Cause of opaque or paradoxical pneumothorax.) *Radiol. med.*, Sept., 1932, 19, 990-995.

The author describes 2 cases of pneumothorax which at first presented the normal picture of a light air space and a darker area corresponding to the collapsed lung. But in roentgenograms taken later the shadow of the air space was darker than that of the collapsed lung. This was due to the fact that the parietal pleura of the air space was thickened while a lobe of lung, adherent to the posterior wall of the thorax, had kept the pleura over the collapsed lung from becoming thickened.—*Audrey G. Morgan.*

OTTONELLO, PIETRO. Sclerosi interlobare del lobo inferior accessorio. (Interlobar sclerosis

of an accessory lower lobe.) *Radiol. med.*, Aug., 1932, 19, 821-825.

A child six years of age had had bronchitis and bronchopneumonia at the age of three, followed by bronchial catarrh and a cough which had persisted up until the present time. Clinically there was tracheobronchial adenopathy and occasionally fever. Roentgen examination showed a triangular opacity on the left side, which was not uniform but made up of rounded opaque areas separated by clearer regions. A little outside of this opacity and parallel with its lateral border there was a slender, intensely opaque line beginning at the level of the 6th rib and running obliquely downward and outward till it ended at the left costo-diaphragmatic sinus. The lower half of the stripe was heavier than the upper part. It was evidently a thickened interlobe separating the left lower lobe from a supernumerary lobe. Such a lobe has often been found both on the right and left sides and is called an accessory lower lobe. The triangular shadow was evidently caused by lesions in the parenchyma of this accessory lobe.—*Audrey G. Morgan.*

VALLEBONA, ALESSANDRO. L'immagine radiologica polmonare a cerchi multipli interferenti. (A roentgen picture of the lung showing many intersecting rings.) *Radiol. med.*, March, 1932, 19, 308-327.

The author describes a roentgen picture of the lungs characterized by many circles which intersect or are superimposed on each other. In some cases the circles are flattened against each other making polygonal figures; these make a network with meshes of various sizes. This picture may cover the whole lung or a large part of it or only a small area. The boundaries of these circles or polygons are very fine lines, about like a "capillary stripe," and like the latter they can only be demonstrated by modern methods of roentgen examination. Four cases of this kind are described and illustrated with roentgenograms. In some cases the pictures look like a sacculated pneumothorax. This is evidently a picture of polycystic lung. It may be caused by bullous vesicular emphysema or by bronchiectasis, particularly the congenital form.—*Audrey G. Morgan.*

OTTONELLO, PIETRO. La rappresentazione radiografica dello sfondato pleurico posteriore. (The roentgen picture of the posterior pleural

recess.) *Radiol. med.*, May, 1932, 19, 469-476.

The so-called posterior pleural recess or sinus is the angle formed where the costal pleura reflects into the diaphragmatic pleura. It is not shown in ordinary roentgen examination because in the sagittal projection it is masked by the liver shadow on the right and the stomach and splenic flexure on the left. The best way to examine it is in the dorso-ventral direction with the patient lying prone. It is a transparent space, grossly oval in shape with its long axis running horizontally. Its upper boundary is formed by the cupola of the diaphragm, its lower boundary by a curved line concave upward, which begins laterally at the wall of the thorax at the level of the lateral costo-diaphragmatic sinus and ends medially near the lateral margin of the first lumbar vertebra; there it turns suddenly upward and is prolonged upward for several vertebrae. It can be shown on both sides. The horizontal part of this line corresponds to the posterior costo-diaphragmatic pleural sinus and the vertical part of it to the posterior costo-mediastinal sinus. It is of value in making a new part of the pleura and lung accessible to roentgen examination.—*Audrey G. Morgan.*

OTTONELLO, PIETRO. La rappresentazione radiografica del lobo polmonare inferiore accessorio. (The roentgen picture of the lower accessory lobe of the lung.) *Radiol. med.*, April, 1932, 19, 390-400.

The author discusses the anatomy of the inferior accessory lobe of the lung, which is not so rare as is generally believed. It is analogous with the infracardiac lobe of quadrupeds. Ettig and Gräberger have described pathological cases which showed triangular basal paramediastinal shadows. The author gives a description of the normal appearance of the lobe on the right side in the roentgenogram of the thorax. The typical finding is a distinct thin opaque stripe representing the interlobular fissure which separates the lower lobe from the accessory lobe. It starts from the vertex of the cupola of the right diaphragm and runs upward and toward the midline in a line that is straight or slightly curved with the convexity outward until it passes into the shadow of the hilus. This stripe is due to the same cause as the capillary stripe of the middle lung field on the right which is caused by the middle interlobular fissure,

and its roentgen characteristics are also just the same. It is easy to differentiate it, however, from the other structures in the region. The author does not discuss the demonstration of such a lobe on the left side under normal conditions, not because it does not occur as often on the left as on the right but because the capillary stripe which bounds it is hidden in the heart shadow. He discusses the importance of recognizing this lobe, particularly when pathological changes take place in it, and the differential diagnosis of triangular basal paramediastinal shadows.—*Audrey G. Morgan.*

DUFALT, PAUL. Basal pulmonary lesions. *Am. Rev. Tuberc.*, Jan., 1932, 25, 17-23.

To rule out pulmonary tuberculosis is a difficult problem in the diagnosis of chest diseases. Basal lesions present considerable difficulty in this field. Review of the literature indicates that basal tuberculosis is extremely rare. Pulmonary tuberculosis is almost never found exclusively in the lower lobe except when this lesion accompanies tuberculosis elsewhere in the body. At the Rutland State Sanatorium in Massachusetts only one case of strictly basal tuberculosis was found in two years.

Many basal lesions of non-tuberculous character have been admitted to the Sanatorium during this time with an incorrect diagnosis of tuberculosis. Five cases are presented, 3 of lung abscess and 2 of bronchiectasis. The conclusive diagnosis was made possible by bronchoscopy and lipiodol injection. The use of the bronchoscope is considered of great value in the differential diagnosis of basal lesions.—*G. R. Miller.*

SICILIANO, L., and BIANCHI-BUONAMICI, C. La linea capillare del polmone destra. (The capillary line of the right lung.) *Radiol. med.*, June, 1932, 19, 571-577.

The so-called capillary line in the upper part of the right lung is generally admitted to be the shadow of the lesser incisure between the upper and middle lobes of the lung. But there is still a difference of opinion as to whether it can be seen in normal lungs or only in those in which the pleura is thickened by inflammation. Vespignani and Lenarduzzi, among others, claim that it can be seen in normal lungs if the right projection is used. They found it in 18 out of 20 individuals with normal lungs. They centered the rays on the 7th cervical vertebra,

giving a projection very oblique from above downward.

The authors argue that the incidence of the rays would be very important if the surface of the interlobe were a plane. Then if the incidence of the rays were exactly parallel to its course it would give a shadow. But the surface of the interlobe is curved anteroposteriorly as well as transversely; therefore the incisure cannot give an exactly linear shadow no matter in what direction the rays strike it. From experiments in which he covered the upper surface of the middle lobe with silver foil, reinserted the lungs in the thorax and took roentgen pictures, and others in which he adapted thin layers of silver foil to curved surfaces of sugar or paper and made roentgenograms, the author concludes that the capillary line represents a certain part of the incisure. The flatter the curve, the more of it can be struck tangentially by the rays and the greater the opacity of the shadow. But the pleura has to have a certain thickness to give any shadow at all and only pleurae that have been thickened by inflammation give such shadows. The authors who have reported large percentages of positive results must have been working with pathological material. Galiffi found only 4.38 per cent positive results in children, who are apt to have normal pleurae.—*Audrey G. Morgan.*

OTTONELLO, PIETRO. La rappresentazione radiografica del margine infero-mediale dei polmoni. (Roentgen picture of the lower median edge of the lungs.) *Radiol. med.*, July, 1932, 19, 704-707.

The lateral projection is not as much used as it should be in examination of the lungs and for this reason the picture described by the author has never been noted before. In normal cases when a lateral roentgenogram is taken at the height of forced inspiration there is a cap-shaped transparent region occupying the posterior part of the cupola of the diaphragm. Diagrammatic sketches are given showing the anatomy of the lower median border of the posterior part of the lung, from which it is evident that the picture is formed by that portion of the lung, which is thick enough to mask the opacity of the subdiaphragmatic organs. The boundary of the clear area is almost continuous with the posterior border of the pericardium. This finding shows a new part of the lung rendered accessible to roentgen examination.—*Audrey G. Morgan.*

KJERP, GUNNAR. Pleural calcification. *Acta radiol.*, 1932, 13, 334-348.

Calcification of the pleura is generally unilateral. It usually develops in the costal pleura and most frequently in males. The localization is generally in the outer part of the middle section of the lung field and need not necessarily be in a thickened part of the pleura. The calcifications vary in number, form and size from granular structures to large bodies and shells which completely surround the lung. The process develops through fibrous and hyaline stages to complete calcification. The chemical composition is the same as that of bone. The condition remains latent or relatively so. The clinical symptoms are the same as those of thickening of the pleura only more pronounced. The diagnosis is made by puncture and roentgen examination. Differential diagnosis must be made from tumor and tuberculosis; this differentiation can be made by stereoroentgenography. The prognosis and treatment depend on associated conditions. There are two elements necessary to cause the disease: a necrotic tissue capable of extracting calcium from the blood and a certain constitution or diathesis, which brings about a change in the solution of the calcium salts. There is generally a history of tuberculous pleurisy or of traumatic hemothorax.

Five cases are described and illustrated with roentgenograms.—*Audrey G. Morgan*:

SCARINCI, CARMELO. Corpi fibrinosi multipli nel cavo pleurico com rara complicità di pneumotorace terapeutico. (Multiple fibrinous foreign bodies in the pleural cavity an unusual complication of therapeutic pneumothorax.) *Radiol. med.*, May, 1932, 19, 485-493.

A few cases have been described in the medical literature in which free fibrinous foreign bodies formed in the pleural cavity in therapeutic pneumothorax. The author reviews them and describes a case of his own. Authorities differ as to the cause of these foreign bodies. Some authors think they are a result of hemorrhage after refilling. Organized extravasations of blood form free foreign bodies. Others think a small blood clot forms a central nucleus around which fibrin stratifies. Still others believe that the bodies are formed by progressive solidification of a serofibrinous exudate. The author believes this theory as there is generally

an exudative pleurisy in these cases and the bodies that have been examined histologically have shown no blood corpuscles.—*Audrey G. Morgan*.

TORELLI, GASTONE. Un particolare quadro radiologico del pneumotorace: il pnx opaco. (An unusual picture in pneumothorax: opaque pneumothorax.) *Radiol. med.*, Feb., 1932, 19, 109-121.

The normal picture of pneumothorax is well known. The collapsed lung gives a dark shadow and there is a clear space corresponding to the air-filled space of the pneumothorax. But in certain cases this picture is reversed, that is, the pneumothorax cavity gives a darker shadow than the collapsed lung. The author describes 12 such cases and gives illustrative roentgenograms. This picture is probably caused by thickening of the parietal pleura around the pneumothorax cavity.—*Audrey G. Morgan*.

ASTI, LUIGI MARIO. Metastasi polmonari osteogenetiche da osteosarcoma del femore. (Osteogenic lung metastases from osteosarcoma of the femur.) *Radiol. med.*, April, 1932, 19, 416-424.

A student of sixteen suffered a trauma while taking gymnastic exercises and shortly afterward a swelling developed on the inner side of the lower third of the left thigh. Biopsy showed osteosarcoma of the femur and the leg was amputated. A few months later he began to have pain in the left shoulder and was sent for roentgen examination. It showed a number of round shadows in the left lung field; they were the size of a pea to that of a large walnut, with distinct outlines and varying sizes. Some of them showed a sort of bone structure with radiating lamellae. There were also opaque nodules in the right lung but they did not show the characteristic bone structure of those in the left. A diagnosis was made of lung metastases from osteosarcoma of the femur. The patient's condition grew rapidly worse and he died in about a month of bronchopneumonia.

The author discusses the differential diagnosis of bone metastases from chondroma of the lung, primary ossifications of the lung, dermoid cysts and calcifications of the pleura.—*Audrey G. Morgan*.

COOPER, FINIS G. The association of tuberculosis and carcinoma. *Am. Rev. Tuberc.*, Jan., 1932, 25, 108-147.

In a review of the statistical data concerning the association of carcinoma and tuberculosis it is difficult to find evidence of antagonism between the two diseases. Conclusions from experimental studies have been contradictory in some cases but most of the evidence at present appears to support the conclusions of those who maintain that tuberculosis and carcinoma are not antagonistic. The accumulation of a large number of cases in which the two diseases have been intimately associated offers fairly convincing evidence that an antagonism does not exist. In many reports authors have attempted to determine which process is primary. Usually tuberculosis was believed to be the earlier process, particularly in the cases in which the conditions were coexistent in the lung and in which the carcinoma appeared to develop in an old tuberculous cavity. In order to determine whether tuberculosis exists with all degrees of malignant tumor, carcinomas were graded according to Broders' index. All degrees of malignancy were noted. The finding of tuberculosis in an organ or biopsy specimen does not exclude the possibility of malignant tumor. It would appear from this study that the association of malignant and tuberculous lesions had better be recorded as a mere coexistence of two diseases until more is known about the cause of carcinoma.—*G. R. Miller.*

ABDOMEN

WAGNER, AAGE. Esophageal orifice hernia. *Acta radiol.*, 1932, 13, 466-482.

The author briefly reviews a number of recent publications on the subject of hernia of the esophageal orifice and then describes the clinical and roentgen findings in 11 cases of this disease. Most of the symptoms shown by these patients were dyspeptic and cardiac and in 8 of them it was overwhelmingly probable that the symptoms were due to the particular type of hernia from which they were suffering. In the other 3 cases there were other causes to account for the symptoms. He believes that operation should not be performed unless it is necessary to save the patient's life. He thinks conservative treatment is effective in the majority of cases.—*Audrey G. Morgan.*

FINSTERBUSCH, R. and GROSS, F. Der Wert des frühzeitigen röntgenologischen Nachweises des spontanen Pneumoperitoneum bei

perforierten Magengeschwür und sonstigen Erkrankungen des Verdauungstraktus. (The value of early roentgen demonstration of spontaneous pneumoperitoneum in perforated stomach ulcer and other diseases of the digestive tract.) *Acta radiol.*, 1932, 13, 567-590.

The results of operation in perforated ulcer of the stomach and duodenum depend chiefly on how soon operation is performed. When a large amount of gas enters the abdominal cavity the liver dullness is decreased or abolished but it is then often too late for successful operation. Very small amounts of gas can be demonstrated by roentgen examination and so diagnosis can be made very much earlier. Roentgen examination can now be made without any danger or inconvenience to the patient by means of horizontal irradiation with the patient lying on his back or side. The authors prefer the left lateral position because in that position very small amounts of gas can be seen more readily in contrast with the dense shadow of the liver, the diaphragm and the lateral wall of the abdomen.

They discuss the literature of the subject and their own results in the examination of 8 early cases of perforated ulcer of the stomach, 2 cases of ulcer of the stomach that perforated as a result of contrast examination, 2 cases of perforated carcinoma of the stomach, 12 of perforated ulcer of the duodenum, 3 late cases of ulcer perforation, 1 of rupture of the small intestine from blunt injury of the abdomen, 1 of gunshot injury of the small intestine, 4 of rupture of ulcers of the intestine from distention in ileus, 1 of perforated appendix, 2 of perforated gallbladder and 5 of postoperative accumulations of gas in the abdomen.

The gas is generally sickle-shaped and even in early cases there may be a fluid level. This point is emphasized because a fluid level has generally been considered an evidence of abscess. The absence of gas does not absolutely disprove perforation but gas is present in a large percentage of the cases—in 86 per cent of 110 cases reported in the literature. The roentgen method has proved of great value in the prognosis of covered perforation. It is also of great value in diagnosing perforations from unusual causes such as stretching of ulcers in ileus and traumatic perforations.—*Audrey G. Morgan.*

JANKELSON, I. R. Peptic ulcers in children. *Am. J. Dis. Child.*, July, 1932, 44, 162-165.

Jankelson reports 3 cases of peptic ulcer in children. The first patient was a boy of twelve years, the second a boy of ten, and the third a girl of twelve. In the first case the roentgen examination showed a niche on the lesser curvature; in the second it showed a persistent irregularity of the duodenum without a six-hour gastric residue, and in the third a prepyloric ulcer with a six-hour residue was noted.

Jankelson concludes that peptic ulcers in children are more common than is generally realized. Many cases are clinically overlooked. Peptic ulcers should be suspected in a child with chronic digestive disturbances not explained by any other demonstrable pathologic process. The finding of occult blood in the stools is suggestive of the condition. A roentgen examination of the digestive tract demonstrating a typical deformity is the only means of arriving at a correct diagnosis. The treatment for uncomplicated peptic ulcer is medical. Complications in cases of peptic ulcers must be treated accordingly, perforations requiring immediate operation, and hemorrhage and a partial pyloric obstruction being treated medically by choice and surgically from necessity only.

Foci of infection, particularly tonsillitis, are common in children, and must be eradicated if the best results are to be obtained. However, Jankelson warns, the removal of healthy tonsils, no matter how hypertrophied, will not help in the control of the symptoms of ulcer; the removal of diseased tonsils, per se, will not cure patients with ulcers. The appendix is sometimes removed as a possible focus of infection. But Jankelson does not regard it as justifiable to expose a child to a major operation in the hope of eliminating a focus of infection which in the individual case may have nothing to do with the presence of the ulcers.—*R. S. Bromer.*

LUPACCIOLU, GIOVANNI. Un caso di ulcera pilorica "vis-a-vis." (A case of ulcer of the pylorus "vis-a-vis.") *Radiol. med.*, March, 1932, 19, 344-346.

A patient aged thirty-nine with symptoms of

stomach ulcer had had several roentgen examinations, all of which had been negative. The author took a number of roentgenograms with the patient in the right lateral position, all of which showed the pylorus filled and on each of its walls, just opposite each other, two opaque spots which were interpreted as ulcer "vis-a-vis," like that described some years ago by Busi in the duodenum. The duodenum and small intestine were apparently normal. The cecum was dilated but mobile and somewhat painful on pressure. The appendix was mobile but intensely painful. A diagnosis was made of ulcer of the pylorus vis-a-vis which had affected the appendix. The patient refused operation on account of the previous negative roentgen examinations. He was obliged to come back about two weeks later, however, on account of copious melena and operation confirmed the diagnosis.—*Audrey G. Morgan.*

ANZILOTTI, ALBERTO. Ulteriori osservazioni su di un caso di tumor peduncolato dell stomaco radiologicamente diagnosticato e operatorio controllato. (Final report on a case of pedunculated tumor of the stomach diagnosed roentgenologically and controlled by operation.) *Radiol. med.*, July, 1932, 19, 717-718.

In an article published in *Radiol. med.*, April, 1930, vol. 17, the author described a case of tumor of the stomach in which the roentgen picture showed a lacunar zone partly in the antrum of the pylorus, partly in the duodenum, from which a diagnosis was made of gastric polyp with a lobulated surface which invaginated intermittently into the duodenum. Operation was advised on account of intermittent melena but the patient refused, so the diagnosis could not be confirmed.

The hemorrhage continued for two years and the patient returned. Roentgen examination showed the same findings and the patient consented to operation. Gastrotomy was performed and the roentgen diagnosis confirmed. A tumor with a long pedicle invaginated into the duodenum, where it extended into the second portion, was removed. Histological examination showed that it was a benign polypous polyadenoma.—*Audrey G. Morgan.*

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THE FUTURE OF RADIOLOGY AS A MEDICAL SPECIALTY*

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THIS American Congress of Radiology is, in a measure, commemorative of thirty-seven years of progress in American Radiology, and there could be no more fitting occasion for such a celebration than that of One Hundred Years of Progress here in Chicago. No greater progress has ever been made in science than has resulted from the discovery of the roentgen ray and radioactivity. It has been fortunate for medicine that these physical agencies could have been so advantageously applied as to have created one of the greatest boons to humanity along medical lines, second only to what has followed as the result of the discovery of bacteria. Radiology is the youngest of the medical specialties, and more rapid strides have been made in its development in a shorter period of time than can be claimed for any of the others.

The true concept of Radiology today is not altogether what we as radiologists think of it as a specialty in medicine, but more important still is the regard which the medical profession as a whole, and even the laity, holds for it and for us who practice it. We as radiologists may assume that our specialty occupies a satisfactory standing, but we have been made to realize at times that we are not above reproach and we must conclude that our position is not ideal in every respect.

Many obstacles have been overcome and numerous pitfalls have been escaped in the nearly thirty-eight years of evolution since the discovery of the roentgen ray. Opportunities for moral and physical obstruction to the advancement of radiology as a specialty have been prevalent during most of this time and are still as active as ever. Probably the most serious of these can be grouped in the inclinations, and even the direct attempts, by various means to belittle our ideals for specialization. But it is by overcoming these obstacles and pitfalls of the past that we have been stimulated to an ethical activity which has placed us in the position we occupy today. Many years ago, in school boy days, I was greatly impressed by a statement accredited to a well-known Philadelphia ship builder, "God bless the man who has placed obstacles in my way." Added years of life's experience have served for personal confirmations of the applicability of this trite saying, and I am sure that the obstacles which we as radiologists have met and overcome have proved to be undoubted stimuli towards the attainment of some of our ideals.

The requirements of specialization in radiology are perhaps more numerous and complex than for any other specialty in our profession, with the exceptions of the major branches of medicine and surgery. This

* Presidential Address delivered before the first American Congress of Radiology, Chicago, Ill., Sept. 25-30, 1933.

statement does not imply, however, that it is more difficult to comply with them nor that a higher standing is warranted than in the other special branches. The very complexity of ideal requirements and the lack of a general understanding of them by other members of the medical profession and the laity is a very important factor in the difficulty in keeping up the high standard which radiology deserves.

In the very early period of the medical application of the newly discovered radiations a cursory knowledge of electricity and of high tension apparatus, together with the ability to carry out the details of dark room development sufficed for the work then possible. That, in fact, constituted my own personal teaching experience thirty-one years ago, in addition, however, to a basic medical training. As a result of the little special training required and the lack of experience available, the institutional druggist or the laboratory assistant or technician could soon learn all there was to be done in the way of technique in the routine examinations then possible. These individuals were designated by such high sounding but meaningless terms as skiagrapher or actinographer. The rapid development of a special line of work in the hands of medical men soon swept these non-professional technicians into the discard, but the stigmata of this early practice in a later specialty still clings to it. It is interesting to recall that surgery developed in much the same way, in being, to a certain extent, in its incipency, in the hands of the barber, although the history of the two specialties is hardly comparable because of the fact that surgery began in the darker ages and radiology in a modern period of enlightenment. They are, in a measure comparable, however, in the fact that medicine was not ready for either procedure as a specialty in the appropriate period of its then undeveloped state.

In later years, we, as radiological specialists, have been obliged to employ non-medical technicians for the performance of a large part of our purely technical work

because we have had to give our time to the far more important phases of interviewing patients, interpretation, consultations, planning treatment to be carried out, working out new technical problems, teaching, writing and keeping abreast of the endless literature on our subject. The employment of technicians to work under our direction has afforded opportunities for an unfortunate aspect to our present situation in addition to being an absolute necessity for our work. The following incidents serve to illustrate this point:

This advertisement appeared recently in a prominent newspaper of one of our large eastern cities:

YOUNG LADY, registered nurse, X-ray expert, industrial clinic experience, needs work; will accept position in doctor's office at reduced salary.

The second example is, perhaps, still more pernicious. A young non-medical man who had obtained training as a roentgen-ray technician was staked by his father to an office and equipment in a city in Pennsylvania of several thousand inhabitants for the purpose of practicing private roentgenological work. In addition to this, he received the appointment as roentgenologist in the local hospital. This young man has progressed so far as to attempt gastrointestinal diagnoses.

In addition to these and very many other similar performances among non-medical individuals of attempting to practice what is generally accepted as a medical specialty, we may step just within the bounds of the ethical scale and include many instances of high pressure salesmanship intended to induce the purchase of roentgen-ray equipment by physicians who have had no training whatever except that necessary to operate the machine, and who are entirely ignorant of the dangers and risks they assume or how to avoid them. It is rather common knowledge that such equipment has been sold in this way under the conveyed impression that training and experience are quite unessential.

It is to be conceded that the technical

side of roentgenology, or at least of the diagnostic aspect, is comparatively easy to master under adequate instruction. It is comparable to the work of the laboratory technician. While correct roentgenographic technique is of the utmost importance, it is, in reality, the simplest and easiest part of the entire diagnostic procedure, and requires little more than a cursory knowledge of physics and electricity to begin with, followed by some experience in handling roentgen-ray equipment, a general familiarity with gross anatomy, a more intimate acquaintance with the relations of penetration, exposure time and thickness and density of the part examined, together with a full realization of the essential safety factors. Strange as it may seem, however, this minor part of the entire diagnostic procedure appeals to a large proportion of the medical profession and the laity as the sum total of an examination and resulting diagnosis. This is frequently due, in a large measure, to the fact that the mysteriousness of the technical portion of roentgenography overshadows the true import of the clinical part of the procedure. As a result of this lack of comprehension we are met by the following undesirable situations which are greatly in need of correction:

1. A large part of the medical profession is quite ignorant of the scope of roentgen diagnosis and radiation treatment, of the principles upon which both are based and of the essentials for proper training of a fully informed specialist in roentgenology. Truly this situation is deplorable in some portions of this country as all of us realize from personal experiences and has been proved by the investigations made by the field representatives of the American Society for the Control of Cancer. Some slight encouragement may be found, however, in the fact that in many localities similar attitudes are prevalent in respect to specialties in general.

2. The second situation has been expressed very appropriately by Dr. Francis Carter Wood in a recent editorial in the

American Journal of Cancer,¹ in which he states that hospital authorities are apt to take the point of view that a roentgenologist is employed by an institution solely to prepare films for diagnostic purposes and to write short, objective reports on his findings, and under many existing conditions the roentgenologist (so-called) is but little more than a glorified technician. To this we might add that such situations are very frequently retroactive, for it is common practice among us, and even among our non-radiological colleagues, to partly judge of the efficiency of hospitals by the clinical and technical quality of the roentgen diagnostic work which emanates from them and the soundness of the principles which quite evidently underlie the character of radiation therapy practiced.

3. A third situation is also covered by a further statement by Dr. Wood, a surgeon, pathologist, radiologist and journalist, and therefore a man who has a full realization of conditions from an unbiased viewpoint, to the effect that many so-called radiologists are not fitted for internal medicine or surgery and take up radiology as a means of living with a minimum of medical knowledge and ability. We must realize that this is only too true and that such individuals never rise much above the level of technicians. As a matter of fact, some of them are very poor technicians, judging by the character of their work which we encounter all too frequently, to say nothing of their opinions.

4. A fourth undesirable situation arises from the fact that quackery is stimulated because of the attitude of the medical profession toward the technician problem. It should be borne in mind that the encouragement of the commercial laboratory under technician control only serves to stimulate fully fledged quackery along other lines. If the roentgen ray is used in a commercial laboratory for the treatment of cancer, and the procedure is encouraged, it

¹ Wood, F. C. The position of the radiologist and radio-therapist in the hospital scheme. Editorial. *Am. J. Cancer*, February, 1933, 17, 462.

is only a slight degree better than the recognition of the "quack" who uses other agencies in the treatment of disease, and which we frown upon and do not recognize.

Having determined what seems to be the most serious situations which react in a manner detrimental to the best interests of radiology and against its best services to the medical profession and to humanity, let us consider the remedial measures best suited to counteract these tendencies. We may enumerate the most important of these as follows:

1. The proper education and training of radiologists.

2. The education of medical students and interns in the true meaning and scope of scientific medical radiology with a view to inculcating in them an ability to decide between useful and useless radiological assistance in their future problems.

3. Avoidance of the commercial laboratory and the recognition of radiology as strictly a medical practice.

4. The moral effect of radiological societies in general and of this Congress in particular.

5. The appointment of a Qualification Board for the approval of radiologists as specialists.

These measures will be considered now in further detail:

1. Much has been written upon the proper education of those who propose to practice radiology, and the subject has been very adequately covered. While these efforts may seem, on the surface, to have been without effect, a few rays of sunshine are beginning to appear through the clouds. The real objects of all the proposed plans of instruction of today are to elevate roentgen diagnosis from purely a laboratory procedure to a clinical specialty, radiation therapy to a rationally scientific and accurate procedure and the radiologist to the position of a consultant in diagnosis, and a highly trained specialist in the treatment of diseases in which radiation therapy is indicated. Failing in these objectives, the would-be radiologist cannot be regarded

as holding a position in higher standing than the unethically adjudged commercial laboratory. The first requisite in his training is a previous clinical experience in both medicine and surgery, if he expects ever to pose as a clinical consultant. This part of his training implies a satisfactory hospital internship, preferably of two years. Following this, it is highly desirable, though not absolutely essential, that he shall have engaged for a while in general practice. During these years of pre-radiological experience, autopsy work will prove to be of incalculable value later on. At the present time the actual training in radiology *must* (not may) be acquired in any one of three ways: as an assistant to a radiologist of recognized standing; as a student in a graduate school of medicine in which provisions are made for a thorough course in radiology; as a fellow in radiology in a busy, and well equipped and manned department in a large teaching hospital. The last two of these means of instruction should cover a period of not less than one year, and preferably twice that long. If the course is but one year, the student radiologist should work for a longer period as an assistant before attempting to practice on his own initiative. It is to be hoped that the stringency of examinations before a future Qualifying Board will be such that even a two years' post graduate training or fellowship will not permit a man to qualify as a specialist, unless by chance he was engaged in radiological work previous to his special course, and for a sufficient time to have acquired considerable experience. A physician with one year's intensive instruction would be far preferable in a small institution, however, to a technician employed for presumable diagnosis without any clinical, pathological or physiological knowledge. In addition to training in radiology alone, there must be inculcated in the properly trained student of radiology a thorough knowledge of physics so far as it applies to his work, because while working, he must always be thinking, though unconsciously perhaps, in terms of the

physical problems at hand. He must also have an intimate knowledge of anatomy and histology. He must be conversant with many problems of physiology, especially in connection with the digestive tract, the heart, respiration and the cerebrospinal fluid system. He must also know physiological actions as they have been determined in some respects only by roentgenological observation, as in connection with the swallowing act and gastrointestinal motility. Above all, he must know pathology, primarily, because the roentgenogram is a portrayal of pathological processes in the living subject and as they may modify or be modified by the functions of life, and roentgenographic interpretations must be made entirely on such a basis. Furthermore, his knowledge of pathology must be applicable to the conditions he may be called upon to treat. Finally, as a diagnostician, he must gain experience in identifying normal roentgenological appearances, variations within normal limits, the recognition of pathological processes and the differentiation between those which present similar abnormal features. All these factors must be adequately developed to admit one to the privileges of consultations in connection with medical and surgical cases and also those falling within the provinces of any of the specialties. Radiologists who give instruction along any of the lines mentioned should be morally bound to select for their students only those who have desirable personalities and abilities such as will tend to elevate the standards of radiology.

2. We still have before us the much discussed problem of the instruction of the undergraduate student whose curriculum is already overcrowded without the addition of radiological teaching. All the specialties are clamoring for a share of the roster schedule. There is no good reason for ascribing this to a purely selfish motive and every specialist on a teaching faculty has a humanitarian basis for his instructional desires. Let us analyze our own motives. The medical student is to become an intern

and eventually a practicing physician. In both instances he is to come daily in more or less intimate contact with some aspect of radiology. He must become familiar with its scope, the indications for its use and its shortcomings, in order to place proper dependence upon it and not waste time, labor or institutional funds or patients' incomes unnecessarily when its assistance is not indicated or required. He must also be able to form some opinion as to which individuals who are radiologists, or posing as such, can assist him by dependable work and advice. He must be one of those in the future to help expurgate the medical field of commercialism, quackery and incompetency. It seems reasonable, therefore, that the undergraduate period should constitute the beginning stage of familiarity with radiology for the reasons stated, and not because of any expectation that he may practice it. It is unnecessary, for the purposes just set forth, that any curriculum be augmented by more than a very small minimum of direct radiological instruction. The necessary rudiments can be readily affixed as portions of the general instruction in the preclinical branches of anatomy, physiology and pathology and the clinical courses in medicine, surgery and the specialties, so far as radiology applies intimately to those subjects. We have fully explained the proposed method in a previous communication,² and we know that such instruction is being carried out successfully in many institutions.

The hospital intern comes in daily contact with radiological problems to a considerable extent, and we have found him particularly receptive to instruction. Moreover, he has more time than the undergraduate student and there is no curriculum to bother anyone. During such an instruction period the elementary principles dealt with during undergraduate years can be greatly broadened, and clinical applications are innumerable. The instruction period is a valuable one and more advantage should be taken of it.

² Pancoast, H. K. Teaching of radiology to undergraduate students. *J. Am. M. Ass.*, 1932, 98, 938.

3. The subject of commercialism has already been discussed from the standpoint of warning the student against it. It is difficult to conceive how any ethical physician can conscientiously do anything to foster its progress as a substitute for professional radiology, which has the recognition of all important medical societies as a specialty in medicine. Commercialism is being encouraged, however, and, sad to relate, even exploited in a way. Truly we must depend upon the education of the undergraduate student and the intern to avoid this calamity to our specialty, and, in the end, to the entire medical profession. We may not be able to influence those of the older generation who lack the proper respect for ethics, but we can persuade those of the next genealogical rank to recognize the great importance of properly trained and experienced radiological specialists.

4. The moral effects of our various societies upon ourselves and others is not fully realized by many of us. In each one of them there is instilled a spirit of cooperation toward the attainment of high ideals which stimulates each member, and especially the younger ones, to do his best for service to mankind as well as his society and himself. There is room for more than one society. Each fulfills a definite purpose and, at the same time, creates a spirit of healthy and profitable competition in scientific radiology. One important duty we all lack, and that is the creation of a cooperative attitude between ourselves and the manufacturers of equipment, leading to the development of apparatus which shall satisfactorily take care of advanced requirements, ensure to everybody the greatest degree of safety in installation and operation, eliminate the useless reduplications of effort for only slight modifications which are conducive to increased installation costs, and, finally, the standardization of parts which would tend to reduce manufacturing costs.

While the four societies sponsoring this Congress may have slightly different minor aims and objects, there are larger problems

which we can work out only collectively. Some of these have already been discussed, and another will be considered next. It seems that our Congress is being held just at the appropriate time to engender a spirit of cooperation between us that is very much needed at present to solve our difficulties and to elevate Radiology to its proper level before the medical profession and even the lay public.

5. Probably the most important step ever taken to place radiology upon an appropriate standing is the formation of a Qualification Board. The proper functioning of such a Board almost automatically creates a standard which will tend to become higher as time goes on, just as have been the experiences following the operations of similar Boards connected with other specialties. The manner in which the inception of our own Board was worked out and the attending incidents were most propitious from the standpoint of the favor with which radiology is viewed by members of other Qualifying Boards, the Council on Medical Education and Hospitals of the American Medical Association and the National Board of Examiners. It is most encouraging to realize that the personnel of our own Board for the Qualification of Specialists in Radiology is now complete and the Board is now ready for definite action. At a meeting in Milwaukee in June of various individuals interested, and prior to the formation of our Board, it was decided to create a general Advisory Committee or Board comprising two representatives from each Qualifying Board, the Committee on Medical Education and Hospitals of the American Medical Association and the National Board of Examiners. This all seems like a dream come true for radiology and we may now hope to have our specialty placed upon a proper basis and some of our serious problems near solution. These happenings of recent months must show us that the specialties of medicine are not self-centered groups, but are cooperative bodies quite willing to help each other when crises arise.

Every radiologist must not jump to the conclusion that he can at once apply to the Board to pass an examination and qualify as a specialist in radiology. The process will, of necessity, be a slow one. The examinations will, or should be, rigid and complete, and there are likely to be many disappointments. A physician's diploma and license to practice medicine permits him also to practice radiology, but only the Board's opinion of his fitness can qualify him to practice radiology as a specialist.

In closing, attention should be called to the fact that we, as radiologists, are apt to think that radiology is entirely what we have made it by our own collective exertions and experiences. In this view we are mistaken, and were it true, we would not have advanced to the position we now occupy. A well-known author³ has stated that "experience has its dangers: it may bring wisdom but it may also bring stiffness and cause hardened deposits in the mind, and the resulting inelasticity is crippling." We must not lose sight of the fact that our progress has been materially abetted by a considerable amount of assistance from outside sources. The physicist, Röntgen, started us on our way, and others of the world's most renowned men of the same scientific group have helped very materially in our advancement. The distinguished Madame Curie will probably have greater renown for what she initiated in radiology than even for what she did for the science of physics. We have called upon the anatomist for help as well as helping him. Where would

we be in therapy today without the incalculable value of the assistance given us by pathologists like Ewing and Broders and others in such important standardizations as the classifications of tumors and their relative radiosensitivity? We have depended upon Failla and his coworkers, working on the latter basis, to tell us how to get an appropriate dosage into a tumor. We have to thank Dandy for surgical procedures making possible the examinations of ventriculography and encephalography, in 1919 to 1920. Graham and Cole first gave us the long desired solution for gallbladder visualization in 1924. We are indebted to Rowntree, Osborne, Sutherland and Scholl for the first intimations of the possibilities of intravenous urography, and to Swick, working with von Lichtenberg, for bringing the procedure into practical use. Mention might be made of a host of others deserving of our gratitude for their assistance in building up our specialty. We must regard all of our own work of nearly four decades aided by the assistance of many willing helpers, as a precious possession not to be robbed of any of its merits by unethical, unscrupulous and non-medical usurpers.

Finally, let us do honor to the host of our fellows who have lost their lives that radiology might advance and that humanity might benefit. We older ones who have survived and the younger generation who have profited by the fatal experiences of our pioneer predecessors must pause and express gratitude to the unfortunate ones who died that we might live and prosper and do honor to their memory.

³Benson, E. F. *As We Are*. Longmans, Green and Co., 1932.



INFLUENCES AFFECTING THE FUTURE OF ROENTGENOLOGY*

By JOHN T. MURPHY, M.D., F.A.C.P., F.A.C.R.

TOLEDO, OHIO

MY FIRST official act as President of the American Roentgen Ray Society is to thank the members of the Society for this honor. When one looks back over the list of the men who have held this office, what they have accomplished for medicine and roentgenology, one is impressed by the honor of being placed in this list and by the responsibility entailed. I hope I may be able to bear the honor with becoming modesty. The responsibility, however, is a more difficult problem.

When the President of the United States is inducted into office, he makes his inaugural address. This is supposed to be a brief review of the condition of the nation as he sees it and such remedies as he may suggest for the solution. So I have prepared a paper in which I shall endeavor to give my views on the condition of roentgenology and some of the problems that we now face.

It may seem trite to say that roentgenology is at a fork in the road. However, I think this is so, for I can see at least three roads it may take. First, it may be absorbed in the general practice of medicine. Second, it may be split up into a number of specialties, and third, it may remain as it is. The underlying forces that may influence its course are complex, and all of the future cannot be foretold today. Nevertheless, it will not be out of place to survey the situation, taking into account the past and the present. In this way we may be in a better position to do our part in shaping conditions, so that whichever road is taken will be the best for the future of medicine.

The Constitution of the American Roentgen Ray Society in its preamble makes two stipulations as objects for the existence of the Society. 1. To improve the science of roentgenology. 2. To maintain roentgenology as a specialty. The first is important

but in my opinion it is no more so than the second, for it is my belief that the future of medicine will be best served if roentgenology remains a specialty, led by men whose entire endeavor is given to this field alone.

Our efforts to improve the science of roentgenology in the past have been well done, and these efforts will be continued. There are some who will say that if we improve the science of roentgenology, it will remain a specialty. They are, I believe, only partially correct, for incorporated in this second stipulation is the economic side. This economic side plays as important a rôle in the future of the science of roentgenology as it does in the entire field of medicine. To me, it seems that as much effort should be made to maintain roentgenology as a specialty as we have used in the past to advance it scientifically.

Most of the branches of medicine took centuries to develop, but roentgenology, the offspring of pure science, born in the most scientific age of the world's history, has matured in forty years. Its advice is sought and followed in all fields of medicine. To understand the problems ahead, if roentgenology is to be maintained as a special field of medicine, one must know something of the conditions which surrounded its birth and growth, what influences affected it during this growth and the problems it now faces, because we, who are its devotees, must meet these problems. Our actions will do much to shape its future.

Let us consider the environment under which early roentgenology was nurtured. When, in 1895, Roentgen's epochal announcement of an invisible ray startled the scientific world, many were the uses suggested. Some were fantastic; some were

* Presidential Address delivered before the American Roentgen Ray Society during the American Congress of Radiology, Chicago, Ill., Sept. 25-30, 1933.

practical. To the serious thinkers it was the dawn of a new era, and they started experimenting. Many men, however, attracted by the unknown, men not well trained, but of an inquisitive mind or mechanical bent also procured the necessary apparatus to produce these new rays. Their tribulations with equipment were many. Much of the apparatus had to be built by the experimenters. Tubes were of the poorest. Exposures were long, and the results were disheartening. But when the basic principle of the rays (the ability to penetrate objects and cast shadows in proportion to their density) was brought to the attention of medical men, they recognized the advantage their use would produce in the localization of foreign bodies and in the diagnosis of fractures. This demand for its use soon became general. As many of the very early experimenters had no medical and little scientific training, it was to these untrained investigators that medical men most often had to turn, for its use demanded that it be obtained wherever possible. In many parts of the country these men were the first to produce roentgenograms.

These first simple uses required little or no medical knowledge, and it was only as progress was made that the necessity of interpretation in the light of medical knowledge became apparent. The fact, however, that many of the early workers were fitted only for the technical work introduced into a medical field men without medical ideals. Many of these men have passed on, or have left the field. Some of these pioneers, stimulated by the contact with medicine, acquired a large amount of medical knowledge and have rendered good service. Some even took the necessary work to acquire a medical degree. To this non-medical influence was added another and more difficult problem. There were no set standards of training and few places to secure even a meager knowledge of the work. Everyone was thrown upon his own resources and acquired what knowledge he could. The field looked lucrative from the outside, and ap-

peared to offer a higher professional standing. As a result many medical men, some failures in general practice, with little special knowledge, entered this field. These men often possessed poor technical ability, and so, to the technician without medical knowledge, was added the poorly trained physician, more dangerous to roentgenology than the non-medical technician, because nothing distinguished him from his well-trained medical colleague.

The older men who have carried roentgenology forward will recognize this picture. It is they who know of the strenuous battles fought around the standards of scientific progress; where, because of a lack of knowledge on the part of the profession and of the laity, reports of the charlatan and the misinformed were given the same credence as were the scientific opinions of qualified men. To men in large centers these days seem long since passed, but I am sure that there are few of them who do not even now have films referred to them for diagnosis in which both the technical skill used and the opinion expressed leave much to be desired.

Lay technicians, who render medical reports, have almost passed. However, because of past history, a heritage still remains in the minds of many persons connected with medicine and hospitals; it is the idea that roentgenologists require no elaborate medical training. Many still feel that the production of films of sufficient excellence is enough, and that anyone can interpret them. This is much in evidence among surgeons and internists, men who would be the first to denounce the roentgenologist for removing an appendix or treating a case of nephritis, but who at the same time do not hesitate to diagnose a gastric ulcer from a set of roentgenograms made by a technician, even though in the present day system of medical training the roentgenologist is far better trained in surgery and medicine than the surgeon or the internist is in roentgenology.

Another factor (and one present from the first, but of growing importance) is that the

general use of roentgenology in medical practice requires that all hospitals be equipped with expensive apparatus, and the personnel to properly operate this apparatus. Sufficient space must be provided for this machinery. These physical and costly sides often overshadow in the lay mind, and often in the mind of the medical staff, the most important part, the correct interpretation of the roentgenograms.

A further complication, resulting from the older days, which, although not justified at present, still persists, began when the profession and hospital authorities saw men of little or no scientific attainments making money out of all proportion to their training and ability. It was only natural that medical men and these institutions should feel that they were overpaid, and that part of this money might be rightfully diverted to the use of the institution. So arose the pernicious idea that the roentgenological department was a legitimate source of income, and a profit from the roentgenologist's efforts could be diverted to other uses. The fact that when medical men became involved this practice was contrary to the ethics of medicine was not only allowed to pass unnoticed by physicians, but institutions were encouraged by the medical staff to do this, because shortsightedly they did not see that this was basic and in time would undermine the entire structure of medicine, sooner or later reacting to their disadvantage by establishing a precedent, a precedent which would quickly be used by the unscrupulous to carry the same practice into their fields. The consultant roentgenologist of the present day (because of the importance of his work) is worthy of and should receive financial returns comparable with any member of the hospital staff.

But today we are primarily interested in roentgenology. We know how the scientific side has advanced. To maintain the standards of scientific advancement, men of ability must be attracted to it, and while I believe but few medical men are actuated by

the emolument offered, when a young man of ability, having a choice of goals, one leading to competence and the medical respect of the surgeon, the other to relative dependence and the medical inferiority of the average roentgenologist, his choice will not be long in the making. The most able man will go into surgery, and leave roentgenology to others less capable. It is in this respect that the economic can do the scientific side irreparable wrong. Roentgenology, called upon to fill a major place in medicine, will suffer scientifically unless it is treated both economically and scientifically as an equal. But you may say that this is so and I will grant that in some places, guided by a strong personality and unusual ability, such recognition *has* been given; but that this is not universal is not hard to prove. One may say that these conditions are often justified, that they are due to the looseness in the use of the term "specialist," to the ease with which one may gain recognition without qualifications, but too many times they are due more to past influence than to the qualifications of the present-day roentgenologist. Poorly qualified men are still to be found, and this is one of our problems.

In looking over the younger men in recent years, one must take heart at their universal excellence, but if you analyze the situation you will find that they have all been trained under the guidance of a few men and at some of the ideal places. Most of them have encountered a rude awakening when thrown upon the practical world, both in the emoluments they may obtain and their standing on the staff of the institution they serve. And this is not due to an oversupply of qualified men. It is due to faulty ideas of their value, and to improperly prepared soil for their reception. The cost of medical care has been much in our minds and the indifference of institutions to good roentgenologists may easily be one of the causes, because good medical care is the cheapest. Correct diagnosis and treatment applied early often obviate costly illness later, and who in medicine at the pres-

ent plays a more important part than the roentgenological consultant?

It will do no good to call attention to improper conditions, if nothing can be done to remedy them. This is not the case in roentgenology. The first and greatest step for proper medical recognition has already been taken—the organization of the Board of Examiners to pass upon the qualifications of roentgenologists. This will take a little time. Many of the older impressions, as I have stated them, will have to be removed, but in the end the stamp of approval placed upon a man by this Board will be necessary to obtain or keep a position on the staff of an institution. This examining work must be conducted with great care, but the quality of the men thus far appointed to this Board (and I am sure those to be appointed) guarantees this end.

However, along with the standardization of the roentgenologist, along with the attempt to establish the economic side, the demand for qualified men must be met. Proper training should be available. The standard for this training should be set, and the practice of clinics of allowing any physician to remain with them for a few days or months should be stopped. Incompetence, when it exists, must be replaced with competence before we have the right to demand equality with the best. Competent roentgenologists should be available to all.

Some of the work for economic equality has already been done. In Ohio the Industrial Commission of the state has now drawn the line between the expense of operation of the roentgen department and the fee of the roentgenologist, considering the roentgenologist's fee as a consultant's fee, to be paid for as for any other consultation. In Cleveland the Hospital Council, through the efforts of the Cleveland Roentgen Society, has agreed to the same principle in all hospital cases.

Scientific progress in American medicine has been due almost entirely to efforts within the profession. The elimination of the ill-equipped medical school, the standardization of hospitals, the standards of the

College of Physicians and the College of Surgeons, all have played their part. We should take the best from the past and perfect our organization in order to make our presence felt, not disregardful of the forces already at work but adding them to our force. To be assured of a just share of the rewards we must bear our share of the burdens. This in the end will react to the advantage of all.

There is yet another problem that confronts us. Again an economic one. The manufacturing of roentgen-ray apparatus is a business. There the ideals of medicine do not touch, but this business is very closely allied to our profession. In the early days the opportunity for profit in manufacturing was small, for the field was limited and the apparatus relatively simple. Now it has grown to a business with millions invested. This business must make a profit, and rightly so, but this profit must come from the roentgenologist. Yet we have no voice in it; we are subject to its dictates. It may falsely spread propaganda about the necessity for this or that, or that this or that is unnecessary. While we may know that both are wrong, we sit idly by or sporadically condemn some small part. No organization has ever taken upon itself to inform other parts of the medical profession, or even the roentgenologists, that these things are against their best interests or the interest of medicine as a whole. Recently business discussions which may cost roentgenologists a large amount of money have been held. We were not consulted and few even here will know to what this statement refers. I maintain we should be heard, that we should be able to speak loud enough for all to hear, and also when heard to be powerful enough to be listened to. All these things can and must be corrected if we are to sustain the second portion of the preamble, "That roentgenology will be maintained as a specialty." And again, I want to say that I believe it should be maintained, and so I make the following recommendations.

1. That the action of the Committee at

Milwaukee with regard to the Examining Board be ratified.

2. That the Junior Membership Amendment be ratified.

3. That a Committee on Economic Relations with Manufacturers be appointed.

4. That steps be taken to change the Constitution so that the dues may be raised.

5. That a permanent secretary be employed, and an organization be established that will look after the roentgenologist's welfare three hundred and sixty-five days a year.

Because it is only by organization and a strong one that most of these things can be accomplished—these things which are vital not only to roentgenology, but to the entire practice of medicine. I realize that

anyone who writes of the economic side of medicine immediately leaves himself open to criticism. If medicine could be divorced from economics I would be pleased, but it cannot, so I make no apology, for I feel that the circumstances demand action. The recommendations I have made I deem essential to our future success. Of course we may muddle through, but personally I would rather stride along doing our share to make the future greater than the past.

Some here present will not agree that these problems exist, or some may agree with parts of what I have said. My recommendations may be deemed exorbitant or inadequate, depending upon the point of view. If they have stimulated thought about the future of roentgenology and its relation to the future of medicine, they are justified.



THE RELATION OF THE AMERICAN SOCIETY FOR THE CONTROL OF CANCER TO RADIOLOGISTS*

By C. C. LITTLE, Ph.D.

BAR HARBOR, MAINE

THE relation of the important field of radiology to the work of the American Society for the Control of Cancer is naturally rather a matter of speculation than of scientific exactitude. The opportunity here to present some thoughts on the question is, however, none the less greatly appreciated.

In order to understand the point of view from which the topic will be discussed it will be well to consider, in order, the nature of the work of the American Society for the Control of Cancer as well as the phases of radiology on which it may properly express an opinion.

1. *The American Society for the Control of Cancer*

The Society concerns itself according to its articles of incorporation with the collection and dissemination of information concerning the symptoms, diagnosis, treatment and prevention of cancer.

Clearly from the foregoing statement the work of the Society does not include either experimental research or the support of research on the part of others. It may, however, cover a very wide investigative study of the actual or relative value of various types of diagnoses, treatments and prophylactic procedures. This it would do in order accurately to *collect* information on which more intelligent opinions could be based. Its major duty is thus education. Broadly considered, its efforts in this field should properly include both the profession and the laity.

In order to accomplish its purpose it maintains, by the representative nature of the personnel which makes up its board of directors, contact with many diverse points of view and focal points of interest. It attempts fairly and wisely to balance claims

and counter-claims of individuals or groups whose efforts or achievements constitute forces of potential or actual educational importance.

The American Society for the Control of Cancer therefore does not concern itself directly with the research phases of the cancer problem. It tries to act in a judicial capacity—sifting the evidence advanced in any part of the cancer field. On the basis of its best judgment it allows reliable facts to determine or to modify its educational efforts. It tries to be conservative, scientific, impartial and concise in presenting educational material to either the profession or the laity. It does not desire or attempt to produce demands for propaganda in the cancer field. It tries to prevent unnecessary misinformation and sensational attempts to exploit the credulity of the public.

In so doing it in no way exercises or claims to possess inspired or infallible powers of discrimination. It is, however, painfully aware of the unfortunate and obstructive effects on education produced by ill-advised and premature publicity on cancer which so often is featured by the press or by unscrupulous or misguided members of the medical or scientific professions. Because of these and other factors opposed to education it adopts an extremely conservative attitude.

Its aim is to cooperate with existing educational agencies rather than to create new ones. Its objective is to guide rather than to impose a fixed and unalterable point of view, policy, or program upon any group or field.

This attitude is an important one to remember in any such discussion as the present. The Society in approaching the field of radiology desires first of all to obtain a fair and comprehensive picture of the

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

efforts towards diagnosis, treatment and prophylaxis in that field. It then wishes to analyze the facts and from them to pick those that are of educational value. These it attempts to synchronize with the other phases of its educational program. The fact that this program is one of correlation and encouragement of constructive activities already created and maintained by those who are giving their lives to their chosen profession should always be borne in mind. The converse, namely, that ill-advised and inaccurate activities are condemned is likewise merely a continuation and amplification of the attitude already adopted by the leaders in the various major approaches to the cancer problem. Among these avenues of attack radiology forms, of course, one of the most important and promising.

Because of the unusual strength and potentiality of the psychological factors in the field of cancer the educational problem is and must admittedly continue to be more complex and its technique necessarily more difficult than is frequently the case in more simple, more easily diagnosed and more controllable diseases.

2. *The Field of Radiology*

The field of radiology is comparatively young and is filled with amazing material for sensational and striking items of great news value.

It possesses certain inherent characteristics that render it a potential force of enormous educational and therapeutic possibilities. It is obvious from a study and analysis of its peculiar attributes that radiology is at once a challenge and an inspiration to an organization like the American Society for the Control of Cancer. Radiology possesses unique educational values and as such entails equally characteristic and original treatment and presentation by any society engaged primarily in educational activities.

While it must be admitted that our understanding of the final educational value of the results of radiological research and

therapy is not and will not soon be well matured there are certain principles already defined which seem worthy of emphasis before this group. Their successful translation into applied educational procedures depends mainly on the degree to which radiologists will assume a cooperative attitude. There is every reason to expect success in this regard. In fact, there are clear signs that the process of cooperation is already well under way and that it will continue and increase.

Let us briefly consider some of the peculiar characteristics of the field of radiology and attempt to evaluate their educational potentialities. No attempt will be made to present these qualities in order of importance. It must be clearly recognized that they are mutually interdependent.

In the first place, the newness of radiology as a field has already been mentioned. Novelty attracts attention; it has great news value.

Discoveries in radiological theory and technique are thus apt to enlist the selfish interest of the press. Once having done so the urge to publicity by those whose livelihood depends upon the journalistic space obtained is almost sure to prove a disturbing factor of importance. Wise newspaper publicity is a great aid to education but—as before stated—premature or poorly prepared statements are of the greatest danger. It therefore behooves radiologists to exercise extreme caution in allowing journalists access to material which can be used for press articles.

Radiology rests upon a scientific basis, which is characterized by numerous points of contact with other fields of scientific research. The complexity of the physico-mathematical foundation of theoretic radiology indicates unmistakably the need for caution in preventing unskilled writers from presenting any discussion of the speculative or theoretic phases of radiology to the laity. Strange and weird press statements of the action of rays have produced among the general public an almost mystical and supernatural regard for the whole subject.

This, in turn, has led to a blind confidence and trust in radiation which imposes grave responsibilities on those who apply this type of therapy. It means that extreme credulity by the public demands a corresponding duty on the part of the profession to be cautious and conservative. To do otherwise means eventually certain disillusionment and a sudden and perhaps fatal reverse of public confidence and goodwill. Whenever such a reverse occurs its effects reach a far larger circle of people than that formed by those at first concerned. Furthermore, lack of confidence in any one branch of cancer research or therapy spreads like wild fire to the whole field and sets back incalculably the whole cause of education in cancer.

Radiology deals with agents of enormous power. The energy involved is easily although often naturally and inaccurately transmuted by the lay mind to relatively familiar energy units such as those of electricity. This again provides a "sales" argument for radiation as a powerful and therefore respectable agent.

The laity is more or less familiar with some of the practical applications of rays of various sorts. The speed of light, the high voltages of electricity, the energy of cosmic rays are today topics familiar to most readers of the daily press. The idea of wave energy is widespread but an understanding of it is rare and conspicuous by its absence. Little or no discrimination between the relative power of various rays is exercised by either the laity or by the rank and file of the medical profession. The enormous influence of radiation of many sorts upon living tissue is as yet feebly grasped by the laity and is altogether too little recognized and assimilated by the profession itself.

The fact that only relatively recently has anything resembling adequate means of measuring the radiation dosage been devised is worthy of far more weight than is commonly given it. In the past far too many physicists with only an elementary knowledge of living matter or medical men

with an elementary knowledge of physics have been allowed to apply radiation therapy. Today there is no valid reason beyond that of inertia which in any way justifies the continuation of such practices. We have learned enough to realize that the interrelation of physics and biology demands in its applied phases a mind or group of minds capable of representing adequately all the constituent elements involved.

The clear evidence that the germ cells and thus all future generations may under certain circumstances be modified by irradiation is also a factor of tremendous seriousness.

When the first statements of this sort were made a somewhat antagonistic reaction on the part of medical radiologists was produced. Some of them marshaled facts to show a large number of instances where no harm was done by irradiation. Others attempted to minimize the importance of the evidence obtained from experimental animals by the old illusory philosophical expedient of emphasizing that man and animals were not identical. As time progressed, however, there has been a steadily increasing willingness on the part of radiologists to welcome the evidence of experimental work. With this has come much more wise conservatism in advocating the use of roentgen rays or radium as means of temporary sterilization or for the treatment of menstrual disorders.

The destructive power of irradiation as well as the growth disturbing and stimulative potentialities possessed by it are therefore weapons of sinister power in unskilled hands.

This is not the time or place to cite instances of this unfortunate procedure. Occasionally an especially flagrant example attracts general attention. Far more often, however, the unfortunate victims of ignorant application of radiation therapy are neither noticed nor recorded. Such abuses form, however, a distinct menace to the much-needed development of radiology. The harm done by them to the individual patient is, from a long time point of view,

small beside the lasting damage which they inflict upon those radiologists and others in the cancer field whose work merits public confidence and support.

The future of radiology thus depends quite as much upon its *wise* development and application as upon its *rapid* expansion in therapy. This is apt to be overlooked both by the commercial groups that derive profit from the increased and uncritical distribution of sources of radiation and by the unscrupulous members of the profession who act as though radiation can be used with the same degree of control and safety as many of the more inert types of therapeutic procedure.

These two abuses form the most serious menace to the progress of any educational program as regards radiology. Recurring cases of tragic results of unwise and unskilled use of radiological agents are certain to produce decreased confidence in the whole field and in the wise and skillful application of radiotherapy. Thus progress is blocked and double harm is done.

Radiology produces in the mind of the average layman a much more pleasant psychological response than does surgery. There is an emotional but entirely human dread of going under the knife. Everything possible is being attempted to dissipate this unfortunate feeling and much is being accomplished. It is, however, certain that treatments with roentgen rays or radium are matters of much more mental comfort to the average man or woman than are surgical operations. They will in all probability continue to be so. This fact imposes upon the radiologist an additional obligation; namely, an unusual degree of confidence on the part of the patient. This must not be abused. It is too valuable a factor both to cancer education and to cancer therapy to fail to protect it by every available means.

The chance of cure of many types of cancer increases directly with the lack of delay in reporting for treatment. Delay is caused not only by ignorance but by fear. The diminution of fear on the part of cancer patients has led to a marked increase in the number of early cases now being reported. Much of this can be credited to the development and spread of non-surgical methods of treatment. As long as such non-surgical methods of treatment such as radium or roentgen rays are skilfully and conservatively applied education will continue to be increasingly effective. The moment, however, that abuses are encountered fear comes back and on its heels stalk delay and death.

The radiologist is thus in a position of *noblesse oblige* as regards cancer education. To the American Society for the Control of Cancer he appears the strongest potential factor in an educational campaign which is sure to be long and slow.

The agents with which he works are of immense power. Their careful control from every angle both in distribution and in utilization is an essential and continuing responsibility. Only by recognizing this fact can the confidence of the public be maintained, the development of cancer education proceed and the increased influence of the radiologist himself be assured.

The relation of the field of radiology to the American Society for the Control of Cancer should therefore be a natural and happy one. Simply outlined, it consists in the recognition by both parties of the great human need of cooperation in the gradual analysis and solution of an enormous educational problem. In this effort success will come only by patience and mutual confidence. The task is important enough to enlist and to hold the sympathetic support of every radiologist and of everyone interested in cancer education.



LIPIODOL IN BRONCHOGRAPHY*

ITS DISADVANTAGES, DANGERS AND USES

By J. BURNS AMBERSON, JR., and H. McLEOD RIGGINS

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SINCE lipiodol and other iodized oils are now being employed so widely for the roentgenographic visualization of the bronchial tree in living subjects, the limitations, disadvantages and potential dangers of the procedure, as well as its advantages, should from time to time be defined more precisely on the ground of accumulating experience. That the lungs usually tolerate the introduction of these oils remarkably well has been demonstrated, but the occasional untoward consequences and uncommon disasters warn against any assumption of assured innocuousness. For this reason the Council on Pharmacy and Chemistry of the American Medical Association³⁴ has recently urged that the injection of iodized oils into the bronchi or other structures should be attended by every possible safeguard. An experience of six years has taught us how to avoid most of the hazards and how to use the oil to secure the greatest diagnostic information. In general, the guiding principles are clearly understandable.

MECHANISM OF ENTRY, EXPULSION AND RETENTION OF LIPIODOL

Lipiodol, gently poured into the trachea of a quietly breathing person in the erect position, can be seen roentgenoscopically to flow rather promptly into the lower large and medium-sized bronchi where for a time further advance is retarded. If, now, the person hangs upside down over the edge of a bed or table and if he does not breathe forcefully or cough, most of the oil will stream back almost as promptly into the throat and can be expectorated. But, if the erect position is maintained, the columns of oil, possibly including entrapped air bubbles, move in a few minutes into the

small bronchi from which also it may be largely eliminated by postural drainage. Independently of posture and gravity some may be regurgitated or coughed up, perhaps aided by contraction of the bronchi. Brauer and Lorey⁸ and Jacobaeus, Selander and Westermarck²⁰ have studied roentgenoscopically the narrowing of the bronchi, which in some subjects occurs a little while after introducing the oil, and interpret this as due to a tonic reflex contraction of the bronchial musculature. We find no evidence that such contraction is long sustained, but the physiologic variation in the diameter and capacity of the tubes can often be demonstrated by the rise of the lipiodol level in expiration and its fall in inspiration. Once the lipiodol has entered the terminal bronchioles and alveoli, part of it is retained usually for weeks and sometimes for many months. This is a disadvantage, and to prevent it one must understand the factors which cause it.

One factor is the fluidity of the oil. Thin oils penetrate readily and rapidly into the alveoli as we have found by using iodized corn oil. Jacchia¹⁹ has made a similar observation with neo-iodipin. The greater viscosity of lipiodol (iodized poppy seed oil) is therefore an important advantage. Curiously enough, this is often nullified by the practice, advocated by some authorities, of heating the oil to facilitate its injection and to avoid inducing coughing. Bloch⁶ has demonstrated how the resulting lowering of viscosity favors rapid and extensive alveolar filling. He finds it best to work with oil at a temperature of 20° to 25° C. (68° to 77° F.), advice which we endorse, having proved to ourselves the wisdom of it during the last two years. In the bronchi, of course, the oil gradually absorbs warmth,

* From the Tuberculosis Service, First Medical Division of Bellevue Hospital and the Department of Medicine, Columbia University, College of Physicians and Surgeons, New York. Presented in abstract before the American Climatological and Clinical Society at Absecon, N. J., May 6, 1932.

but in the interval before the alveoli have become widely filled the roentgenogram can be taken and the patient then immediately inverted for postural drainage.

Another factor of prime importance in this respect is violent respiratory effort such as deep forceful breathing, heaving, and especially coughing. If, with the bronchi of a section of one lung filled with lipiodol, the patient coughs violently, the contrast material can be seen roentgenoscopically to be literally blasted, not only into the immediately tributary alveoli but also into bronchi and alveoli of other sections of the same and sometimes also of the opposite lung. Brown and Archibald,¹⁰ by a most instructive experiment with cats, demonstrated how the force of coughing expels thick, tenacious sputum from the bronchi but exerts an opposite effect on thin fluid material such as pus or lipiodol itself which is actually driven farther into the terminal air passages. The operation of this mechanism undoubtedly helps to explain the propagation of pulmonary infection and to account for some of our unfortunate experiences with lipiodol bronchography described below.

Noting that bronchioles in both the living and dead lung become filled with lipiodol more rapidly than glass tubes of the same diameter, Brauer and Lorey⁸ suppose that air may escape through the interalveolar pores from alveoli tributary to the filled bronchi. The resulting vacuum would then actively suck the oil into the bronchioles. This, however, is a dubious theory in view of the known tendency for airless alveoli to collapse and of Van Allen's^{39,40} recent experiments on collateral respiration.

The retention of lipiodol, once it enters the alveoli, is due apparently to the ineffectiveness of further coughing, the force of gravity, physical adhesion between the oil film and the alveolar walls and possibly a narrowing of the draining bronchi by tonic contraction and the fixation of the substance by biological processes such as phagocytosis. Why in some cases the retained lipiodol is eliminated in a few weeks

and in others not in many months must depend on a number of factors, one of the most important being the depth and extent of penetration by forceful breathing and coughing at the time of filling. The common practice of advising the patient to cough up the material after the bronchogram has been made is reprehensible. Postural drainage *without coughing*, as described below, is the more adequate and safer means of elimination. It is generally known that the oil can be drained more easily from bronchiectatic areas than from healthy sections of the lung, due obviously to the fact that the communicating alveoli have been destroyed or ingress to them is blocked.

FATE OF RETAINED LIPIODOL AND EFFECT ON NORMAL LUNG

By measuring the urinary excretion of iodine Sicard and Forestier³⁶ in the early days of their work found that as much as 29 per cent of the iodine content of lipiodol injected into the bronchi was finally eliminated through the renal portal. They took this as evidence of "lipodieresis" and absorption by the lung, according to the mechanism described by Roger.³⁵ They failed to allow for the regurgitation and swallowing of oil which usually attends or follows intratracheal injection, and the resulting intestinal digestion and absorption. Eliminating this source of error and using an oil which may be more firmly bound chemically, Knipping and Ponndorf³² studied the question and observed no significant absorption from the lungs of man or animals. Grill¹⁶ takes the same view, having found no chemical evidence of lipiodol splitting in the post-mortem study of a lung six months after injection. Even allowing for some slow removal by absorption, it appears that most of the material is discharged through the bronchi and that the failure of this mechanism to operate adequately accounts for the retention in some cases. Occasionally it is possible microscopically to detect oil droplets in the sputum for weeks after the injection.

Apprehension that lipiodol, retained in

the lungs after intratracheal injection, might set up damaging tissue reactions was based largely on the known effect of other oils as found experimentally, for instance, by Waters, Bayne-Jones and Rowntree¹¹ in 1917 and later by Guieysse-Pellissier,¹⁷ and Corper and Freed,¹¹ and reported more recently in human beings by Laughlen,²⁴ Pinkerton³² and Pierson.³⁰ Changes in severity varying up to consolidation, caseation necrosis and fibrosis were observed. Pinkerton,³³ however, demonstrated that the type of reaction in rabbits' lungs depends to a great extent on the kind of oil used. Animal and mineral oils provoked considerable inflammation while vegetable oils, including olive oil and lipiodol, caused a relatively mild change. Animal experiments conducted later by others tend to bear out Pinkerton's general conclusion with regard to lipiodol, at least within several months after injection. A study of the reports of Fried and Whitaker,¹⁴ Brown,⁹ and Bettman, Kelly and Crohn⁴ gives the impression of a consensus among these workers that there is a prompt reaction of the "lining" cells (perhaps with an infolding of these) of the alveoli and that oil droplets may be engulfed by the same cells, some of which accumulate as tumor-like masses in the alveolar spaces. Occasionally some of the oil may enter the capillaries (Fried) or the lymphatics (Brown). Duken and von den Steinen¹² found only an exudate in the alveoli of animal lungs and this was poor or lacking in cellular elements. At the other extreme Brauer and Lorey⁸ observed no damage whatever from iodipin (apparently the same as lipiodol) in the lungs of dogs, geese and human subjects. Peiper and Klose²⁹ alone induced severe pneumonia in two dogs, one of which died twenty-four hours after the injection, the other being killed at the end of nine days. Such varying observations suggest that a number of factors play a part. The chemical makeup of the iodized oil may be one. Sicard and Forestier caution against the use of stale, brownish oil which presumably may contain fatty acids and free iodine.

Even fresh oil may contain a trace of free acid (Winternitz;⁴² Greenbaum¹⁵). The kind and age of the animal may make a difference. The amount of oil used and the method of injection (with or without force), the preëxistence of pulmonary inflammation and the possibility of carrying down infectious organisms from the mouth and throat all have to be given due consideration as they may have an important bearing on practical clinical work.

The collective clinical experience of many workers indicates that no serious immediate tissue damage is to be feared from the presence of lipiodol per se in the healthy lung provided certain conditions are observed in the technique. Physiological disturbances, usually mild, may occur, however. We have not seen in healthy persons the development of a roentgenographic lobar opacity which Jacobeus, Selander and Westermark²¹ and Pinchin and Morlock³¹ have diagnosed as *acute massive atelectatic collapse*, and these are the only reports of the kind we have found in the large literature on bronchography. In Pinchin's case the lobar opacity appeared in the short space of three minutes after the oil injection, and in Jacobeus' 4 cases within ten to fifteen minutes. The amount of lipiodol used bore no apparent relationship to the result noted. The explanation of the occurrence is not very convincing. In the first place there is reason to doubt that the much discussed and variously described condition of so-called massive collapse represents real atelectasis (simple airlessness and collapse of the alveoli) in the strict sense of the word, and the same may be said of the cases of these authors. In many such instances it is more probable that the radiopacity is due chiefly to a rapid flooding of the lobe or lung with transudate (edema). An evidential fact is that most patients expectorate quantities of watery sputum shortly after the "massive collapse." We see this often during and after lipiodol injection, and two of the Jacobeus patients in question raised copious amounts. In his study of the movement

are not visible on the roentgenogram. In the questionable early cases, when laboratory data are essential for the determination of the type of disease, the roentgenogram offers little impetus toward the swing of the pendulum to one side or the other. In moderately advanced cases of disease it may offer a more accurate aid to diagnosis.

SUMMARY

A comparison is made between the roentgenogram and the gross and microscopic pathologic specimens in 65 cases of tuberculosis and 11 cases of nontuberculous arthritis of the knee joint.

In a large percentage of cases the roentgenograms accurately demonstrate the existing pathologic lesions, but, because of the similarity of the two processes, cannot be considered in most cases as dependable diagnostic evidence.

The principal shortcoming of the roentgenogram is the failure to demonstrate the early pathologic changes in bone or synovia and the presence of areas of sequestration.

The principal advantage of the roentgenogram is the demonstration of lesions of the bone which may remain hidden beneath more superficial disease of the synovia or even beneath structures that appear to be perfectly normal.

REFERENCES

1. ALLISON, NATHANIEL. Tuberculosis of the bones and joints. In: Lewis, Dean: Practice of Surgery. W. F. Prior Co., Hagerstown, Md., 1929, iii, 1-64.
2. ELY, L. W. Joint Tuberculosis. William Wood and Co., New York, 1911, 243 pp.
3. FRASER, JOHN. Tuberculosis of the Bones and Joints in Children. A. and C. Black, London, 1914, 352 pp.
4. GHORMLEY, R. K. Joint disease: a clinical-pathological study. *J. Bone & Joint Surg.*, 1926, 24, 858-883.
5. GIRDLESTONE, G. R. The pathology and treatment of tuberculosis of the knee-joint. *Brit. J. Surg.*, 1932, 19, 488-507.
6. KÖNIG, FRANZ. Die Tuberculose der Knochen und Gelenke. Auf Grund eigener Beobachtungen. A. Hirschwald, Berlin, 1884, 169 pp.
7. KÖNIG, FRANZ. Die Tuberculose der menschlichen Gelenke sowie der Brutswand und des Schädels; nach eigenen Beobachtungen und wissenschaftlichen Untersuchungen. A. Hirschwald, Berlin, 1906, 166 pp.
8. LERICHE, RENÉ, AND POLICARD, ALBERT. The Normal and Pathological Physiology of Bone; Its Problems. C. V. Mosby and Co., St. Louis, 1928, 236 pp.
9. PHEMISTER, D. B. Changes in the articular surfaces in tuberculous and in pyogenic infections in joints. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1924, 12, 1-14.
10. PHEMISTER, D. B. The effect of pressure on articular surfaces in pyogenic and tuberculous arthritides and its bearing on treatment. *Ann. Surg.*, 1924, 80, 481-500.
11. SUNDT, HALFDAN. The diagnosis and frequency of tuberculous disease of the knee. *J. Bone & Joint Surg.*, 1931, 29, 740-758.
12. WOLDENBERG, S. C. The pathology of the knee-joint in relation to X-ray findings. *Surg., Gynec. & Obst.*, 1920, 31, 366-371.



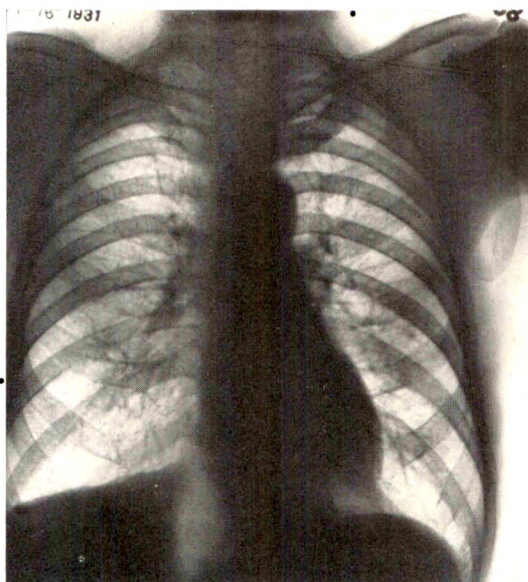


FIG. 1. Case J. B., admitted on account of hemoptysis; râles in right upper lobe.

of body fluid into and out of the lungs, Swindle³⁸ has shown how delicate is the regulating mechanism and how easily it can be thrown out of balance upon interference with respiratory function. In the light of such knowledge, it is not surprising that even mild irritants such as lipiodol should excite a reaction with edema. As shown by Duken and von den Steinen¹² the edema fluid may occupy only a limited section of alveoli, but under unusual conditions it is conceivable that the reaction might involve much wider sections, thus explaining gross roentgenographic densities. Chevalier Jackson's term "drowning of the lung from within" seems appropriate whether the cause be lipiodol filling or some accident such as abrupt massive pulmonary hemorrhage. In the cases reported by Jacobeus and by Pinchin the roentgen shadows cleared rapidly—easily explainable by the discharge and absorption of the transudate.

Jacobeus and Pinchin suppose that the lobar opacity may represent a collapsed lobe from which the air has been expelled by bronchial spasm induced by the injected lipiodol. This theory is not new and is largely hypothetical. It is known that bron-

chial contraction, and sometimes severe spasm, attends lipiodol injections. But, while this, together with the obstruction caused by the oil, may at times interfere with proper aeration, it is not clear how this mechanism alone could effect a massive collapse in so short a time.

Whether the retention of lipiodol in the alveoli for years is actually harmful remains in question. The development of foreign body granulations has been strongly suggested in some cases by clinical observation but no one as yet has reported the histological appearance of such a lung.

Diagnostic Disadvantages of Retained Lipiodol. From the roentgenological point of view these deposits are at times a serious disadvantage. In addition to the hard shadows of the lipiodol itself the surrounding alveolar exudate produces a soft perifocal halo. The peculiar lobular shadow, designated by Lenk and Haslinger²⁵ as a "contrast medium infiltrate" (Kontrastmittelinfiltrate) resembles that of bronchopneumonia except for the dense centers. Later, as the oil is gradually eliminated the fading residual shadows are even more confusing.

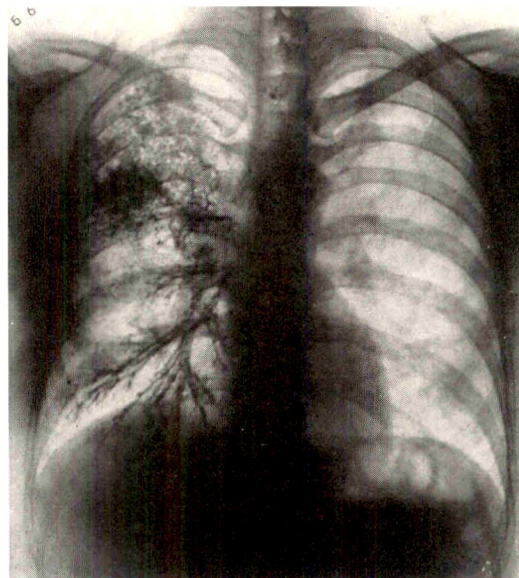


FIG. 2. Lipiodol bronchogram of Case J.B. No definite abnormality of the bronchi. Extensive filling of bronchioles and alveoli in right upper lobe.

CONGENITAL ABSENCE OF THE SUPERIOR ORBITAL WALL ASSOCIATED WITH PULSATING EXOPHTHALMOS*

REPORT OF FOUR CASES

By LEON T. LEWALD, M.D.

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THE recognition of congenital absence of the superior and posterior orbital walls is of extreme importance in roentgen diagnosis.

In the first case which I observed in 1926 a previous erroneous diagnosis of sarcoma of the orbit with destruction of the orbital bony structures had been made, and the advisability of enucleation of the eyeball had been discussed (Fig. 1). In a some-

what similar case reported by Rockliffe and Parsons³ actual removal of the orbital contents preceded by ligation of the carotid artery was performed and was followed by the death of the patient. In this case the whole of the bone of the orbit except for the floor and outer wall had never developed. Moore of London reports 4 cases² in all of which there was an associated diffuse neurofibromatosis or Recklinghausen's disease and pulsating exophthalmos. In at least 2 of the 4 cases here reported there was evidence of neurofibromatosis, and all 4 cases had pulsating exophthalmos. One of the cases in addition had localized gigantism of the right leg due to a congenital arteriovenous fistula as described by Horton.¹ This case also had a congenital deformity of the cervical vertebrae.

CASE 1. Female, aged fifteen, was referred to me on September 20, 1926, by Dr. Arthur A. Boyer, with a question of erosion of the left orbit, about which there had been a difference of opinion, some having considered the lesion as sarcoma of the orbit (Fig. 2). This case gave a history of poor sight and nystagmus since birth, left eye. Pulsating tumor of left orbit increasing very slightly since birth had been noted. Was a seven months baby delivered without instruments. On May 12, 1923, Dr. Wurdeman, Seattle, Washington, made an examination and reported sight of right eye 6/15, left eye 6/60. Head dolichocephalic. No pain. Internal strabismus, left eye, and slight ptosis. The father, an army officer, was transferred to New Jersey for recruiting duty and the patient was to enter a school in Orange. The excitement brought on a temporary increase in the exophthalmos and the pulsation. She had also been seen by Dr. Arnold

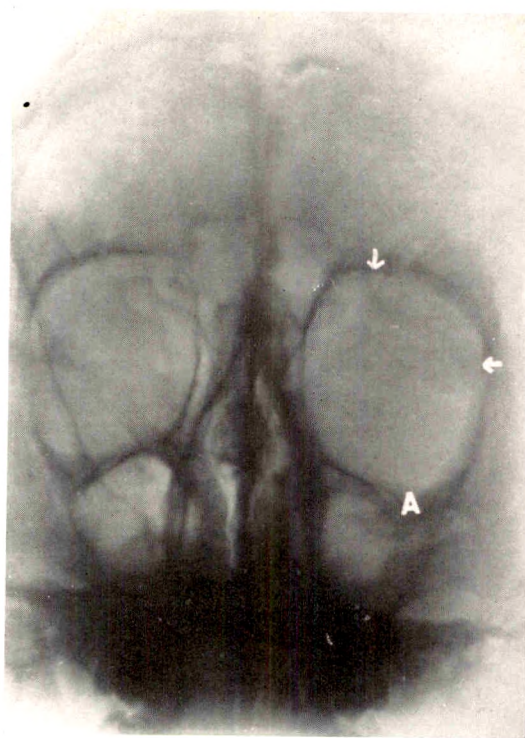


FIG. 1. Case 1. Congenital absence of the superior orbital wall, left side. Note the absence of bone detail on the left side, and the dropping of the orbital floor, A, and diminished size of the maxillary sinus.

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

Such infiltrates have been mistaken by x-ray interpreters, according to our records, for the following conditions: bronchopneumonia, tuberculosis, bronchiectasis, pulmonary fibrosis, calcified lymph nodes and calcification of the pleura (Figs. 1, 2 and 3). Conversely, in one case of nodular fibroid and calcified tuberculosis the roentgen diagnosis was "retained lipiodol." When associated with the shadows of morbid lesions, these persisting densities are often a great nuisance if one is obliged to lean heavily on serial roentgenograms for the regulation of treatment.

In several cases we have observed an especially confusing roentgen picture, erroneously interpreted as bronchiectasis, produced by the injection of lipiodol by the bronchoscopic method. A pooling of the oil in the pulmonary tissues can be easily created by forceful injection through the bronchoscopic cannula.

DISADVANTAGE AND DANGER OF THE CRICOTHYROID MEMBRANE OR TRANSTRACHEAL METHOD OF INJECTION

Many prefer this method, the needle being inserted directly through the crico-

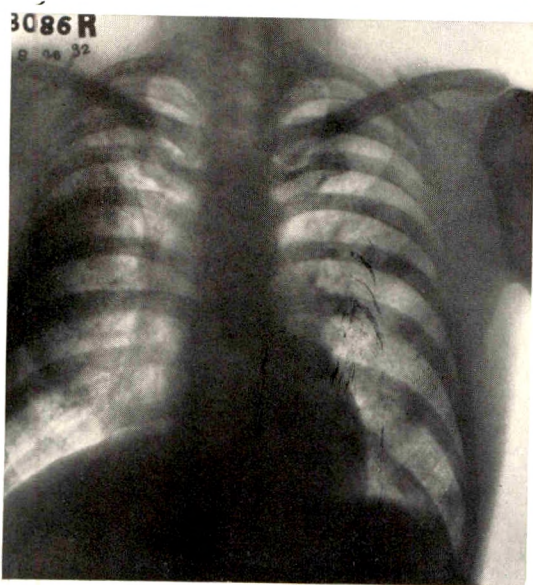


FIG. 3. Case J.B. (Oct. 28, 1932). Shadows of retained lipiodol instilled in right upper lobe almost four months previously (lipiodol infiltrate).

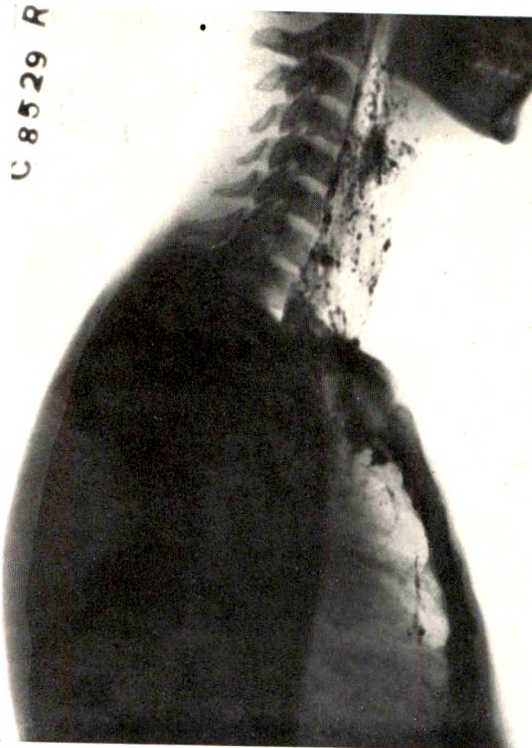


FIG. 4. Case S.L. Lipiodol injected by cricothyroid membrane route three years previously. Evidently most of this escaped into the tissues of the neck. Roentgenogram shows lipiodol deposits in the tissues of the neck and also extending low into the mediastinum.

thyroid membrane. This technique, or preferably a modification of it described below, is useful in children but it has the disadvantage that lipiodol may escape into the cervical tissues, particularly if the patient resists and moves. Following the fascial planes, the oil may then gravitate into the retrosternal tissues where it remains for years (Fig. 4). In their monograph, Bonnamour, Badolle and Gaillard⁷ assemble the published reports of difficulties arising from this cause. These include pain at the site of injection, dysphonia, edema of the glottis, dysphagia, and subcutaneous emphysema. During an injection by the cricothyroid route, Olmer and Zuccoli²⁸ observed evidence of transitory air embolism in a man of thirty-nine, while Köhler²³ reports mediastinal emphysema and fatal air embolism in a boy of nine. We prefer intro-

Knapp and Dr. Weeks. Dr. John Wheeler saw the case with me in consultation and agreed with the diagnosis of congenital absence of the superior orbital wall, associated with pulsating exophthalmos.

This case was successfully operated on by Dr. Walter E. Dandy of Baltimore on July 15, 1927 (Fig. 3). The following extracts are made from his report of the case.

"Aside from the local condition and related functions, a minor congenital deformation of the ear and marked thinning of the skull in the frontal region (lateral view), the physical and neurologic examinations revealed nothing of unusual interest. Her general condition was excellent.

"On looking at the eye from a lateral position, a pulsation, synchronous with the pulse, was easily seen. It was also palpable, but there was no thrill. No murmur was audible. Roentgenograms of the skull taken laterally and anteroposteriorly (both stereoscopic) showed that the posterior half of the roof of the orbit was missing. There was a small shelf internally and externally.

"A transplant of bone from the outer table of the skull was bridged across the roof of the orbit (Fig. 4). The curvature of this bone was essentially the same as the arch of the orbital roof. Moreover, the external and internal margins of the orbit were ade-

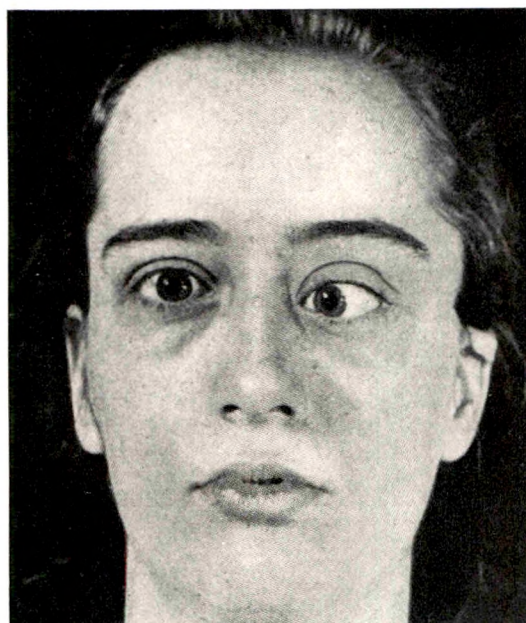


FIG. 2. Case 1. Note protrusion and slightly lower position of the inferior margin, left eye. Clinical diagnosis: pulsating exophthalmos. A previous erroneous diagnosis of "sarcoma" had been made.

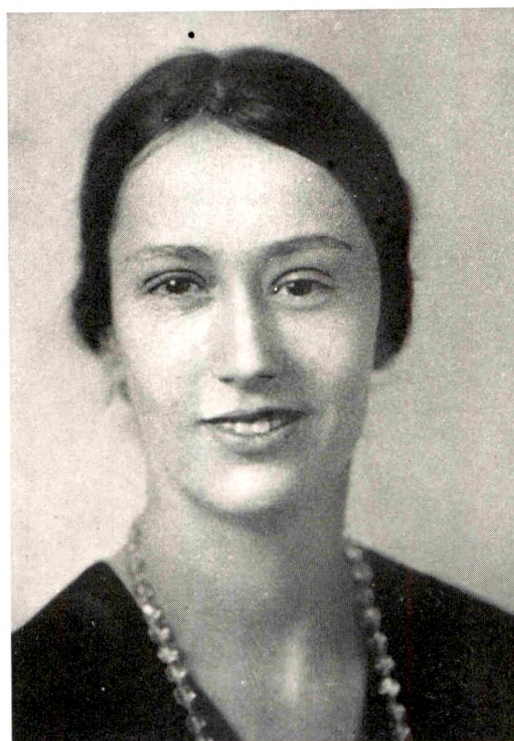


FIG. 3. Case 1. Three years after bone transplant from temporal region of skull. Exophthalmos and pulsation cured. (Operation by Dr. W. E. Dandy.)

quate to give a base on which the graft could rest and to which it should ultimately unite. A bed was chiseled from the external rim of the orbital roof where it joins the side of the skull, and into this notch the outer margin of the transplant fitted accurately and firmly. The graft was passed through a tunnel between the dura and the orbital contents. The inner margin of the transplant rested on the inner rim of the orbital plate, from which the dura and periosteum had been scraped to permit the transplant to lie in apposition with bare bone. The ends of the graft fitted so accurately that it was not necessary to wire the graft in place. The new superior orbital fissure was probably a little wider than normal but the difference was not great.

"Other details of the operation and abnormal observations: The outer surface of the brain was covered with large pools of fluid in the subarachnoid space; the leptomeninges were opaque and greatly thickened. The release of this fluid yielded adequate room to permit elevation of the brain without producing trauma. It was not necessary to puncture the lateral ventricle or to withdraw spinal fluid by lumbar puncture, as is the custom when intracranial room is at a premium. On retraction of the frontal lobe the defect in the posterior two-thirds of the orbital roof showed precisely as in the roentgeno-

ducing the needle between the cartilaginous tracheal rings. Using this method only in children, we have seen none of the above-mentioned accidents except a little local

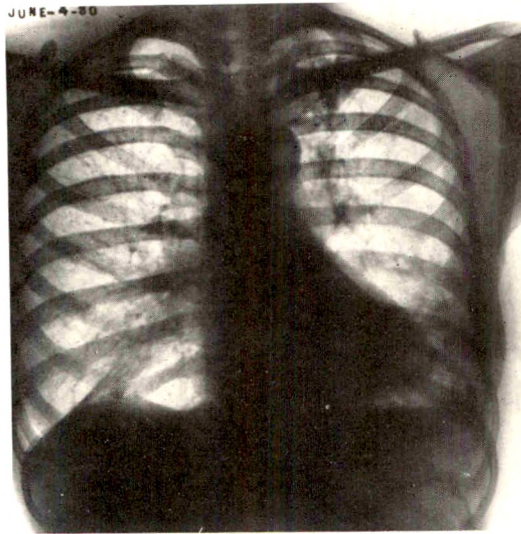


FIG. 5. Case V.P. (June 4, 1930). Tuberculosis in upper and lower one-fourth of left lung; fibrosis at base of right lung.

pain. The danger of escape of infectious material into the neck through the puncture wound is definite, especially when there is copious bronchial discharge. In one of our patients, a child, a phlegmon of the neck developed, and surgical incision was necessary. Bonnamour et al. comment on the rather numerous reports of such infection, some of which are very serious (gangrenous), and cite a fatal case reported by Loederich and another by Comte.

Excepting contamination with bacteria, lipiodol retained in the tissues of the neck or mediastinum seems to do no harm. Nevertheless, one cannot view with indifference the prospect of indefinite sojourn of the foreign substance which will cast its telltale shadow whenever a roentgenogram of the patient's chest is made.

IODISM

Mild iodism has not been uncommon in our experience. Usually, because of the coryza, tracheitis and low fever, the pa-

tient thinks he has caught cold. Only 4 of our patients had slight skin eruptions. As a rule, the symptoms appear in twenty-four hours but occasionally they may be delayed for a few days or a week. The catarrhal symptoms are usually gone within two days. Since iodism is due mainly to intestinal digestion and absorption of the swallowed oil, prevention depends on postural drainage and expectoration of the material immediately after the roentgenogram is made. Assuming that some, nevertheless, may be unavoidably swallowed, it is preferable to carry out the procedure when the patient's stomach is empty and, after postural drainage is completed, to administer orally a dose of Epsom salt. It is then unnecessary to wash the stomach or to give a preliminary test dose of potassium iodide as advocated by some.

The chief dangers from lipiodol instillation into the bronchi by any method fall

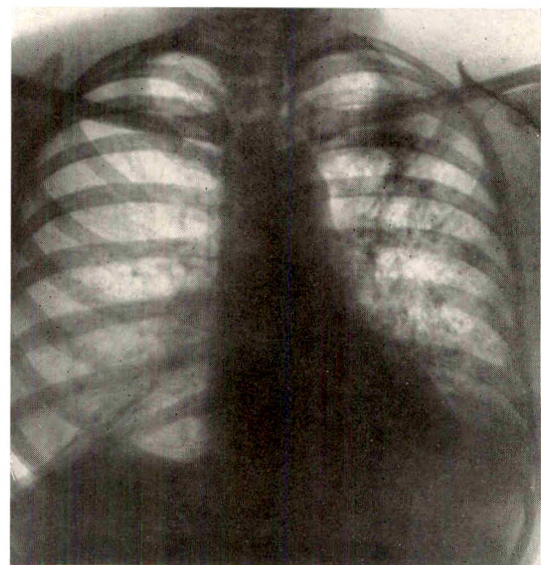


Fig. 6. Case V.P. (Nov. 10, 1930). Shadows of lipiodol retained in the alveoli of the middle and previously healthy section of the left lung.

into two general classifications, viz., those traceable to dissemination or aggravation of infection, and those depending on a mechanical or physiological disturbance of the respiratory or cardiorespiratory function.

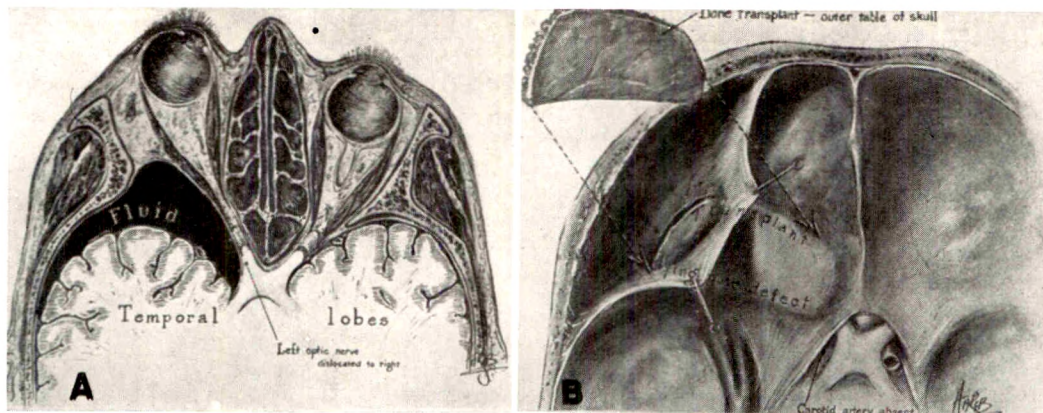


FIG. 4. Case 1. A. Dr. Dandy's sketch showing operative observations. The bed of fluid represents the meningocele which is pushing the orbital contents forward, downward and inward. B. Drawing to show the implantation of the bone through a subdural tunnel. The bone rested internally and externally on solid bone.

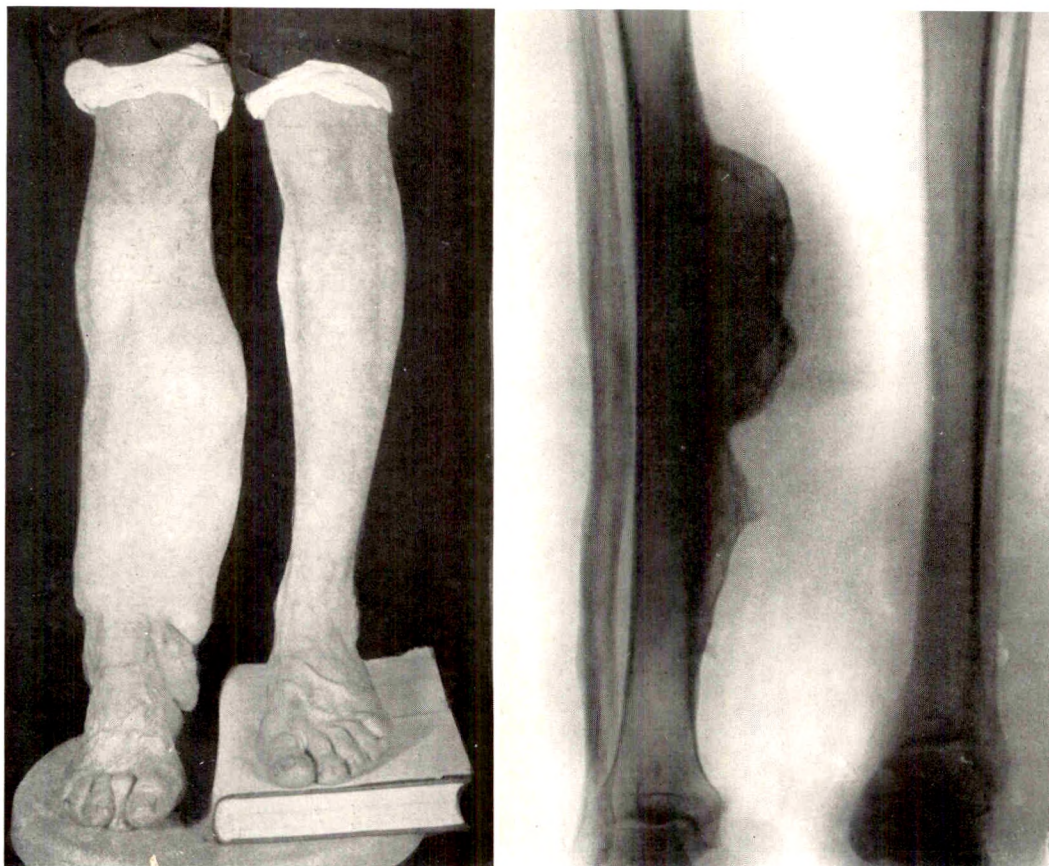


FIG. 5. Case 11. Congenital absence of the superior orbital wall, left side. Localized gigantism of right leg associated with exostoses and increased length between knee and foot. This condition may be due to congenital arteriovenous fistula (Horton).

DISSEMINATION AND AGGRAVATION OF INFECTIOUS PROCESSES IN THE LUNGS

Using care to avoid carrying down contaminated secretions from the mouth and throat, we have never been able to trace infection of a previous healthy lung to lipiodol injection. However, if the bronchi or lungs are already diseased, as they usually are in cases selected for this procedure, the hazards are real, and we have a number of unfortunate results to report.

Dissemination of Tuberculosis. The first case illustrates the rapid spread of pulmonary tuberculosis following the intratracheal instillation of lipiodol.

CASE V.P. A negress, aged thirty-one, entered a state sanatorium, June 4, 1930, on account of tuberculous infiltration with several small cavities in the upper and lower quarters of the left lung and fibrosis at the base of the right (Fig. 5); evidence also of a mitral valvular heart disease. She raised half an ounce of sputum

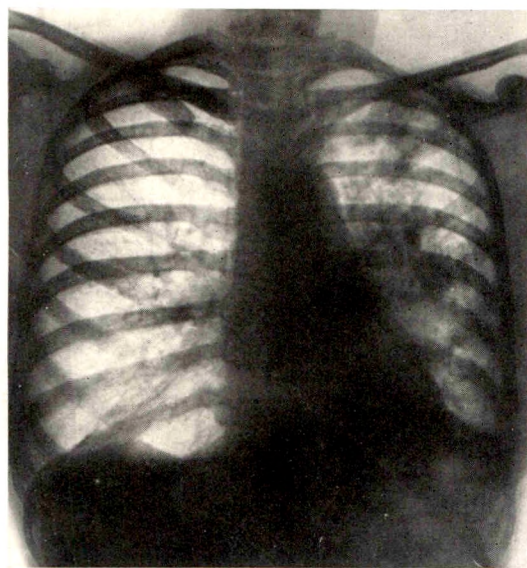


FIG. 7. Case V.P. (Nov. 28, 1930). Acute spread of tuberculosis in the middle one-third of the left lung where lipiodol was retained. Disease progressed rapidly after this.

daily, and this contained tubercle bacilli. Because of recurrent attacks of dyspnea and wheezing, lipiodol was instilled by the transglottic method mainly into the bronchi of the

left lung, September 6, 1930, in an attempt to demonstrate a suspected obstruction, but none was found. The roentgenogram of October 25, 1930, shows retained lipiodol (lipiodol infil-

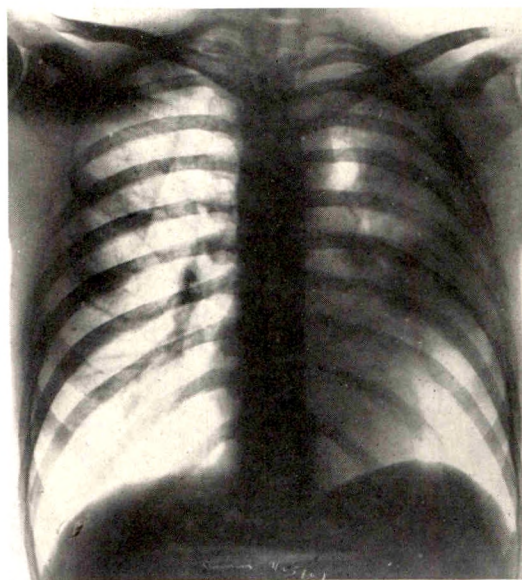


FIG. 8. Case T.A. (July 25, 1927). Large lung abscess in the upper two-thirds of the left lung; lower one-third clear.

trate) in the middle third of the left lung and a slight increase of the tuberculous process in the upper third. On the same day lipiodol was again injected, and the roentgenogram of November 10 (Fig. 6) still shows many retained lipiodol deposits in the lower two-thirds of the left lung. The patient improved, gained 7 pounds and rarely had a temperature above 99.6° F. until the date of her discharge, November 20, 1930. Four days later, on entering Bellevue Hospital, she was greatly prostrated, had nausea and vomiting and paroxysms of dyspnea which we attributed largely to the heart disease. Blood Wassermann negative. Blood leucocyte count, December 4, 10,000; 71 per cent polymorphonuclears; 26 per cent lymphocytes. The sputum increased and the temperature rose to 102° or 103° F daily. A roentgenogram (Fig. 7) demonstrated a rapid spread of the tuberculous infiltration in the middle third of the left lung, a previously clear region where the lipiodol was mostly retained. The patient left the hospital December 21, 1930, and died March 19, 1931.

We have a second case (E.E.) previously

gram. The bony defect was everywhere covered by dura which was firmly attached to the eyeball. The dura extended backward with a gradual decline to and across the floor of the middle fossa. An isolated small fragment of bone lay between the dura and the eyeball.

"The tip of the temporal lobe was covered by tremendously dilated subarachnoid spaces, with opaque membranes—changes not unlike those on the surface of the brain, except in degree. Superficial examination might well give the impression that the tip of the temporal lobe, which was entirely hidden from view, was covered by an actual cyst. These large subarachnoid spaces were continuous through the sylvian fossa with similar spaces over the frontal and parietal lobes. The maximum depth of fluid was about 2.5 cm. The intact temporal lobe lay beneath the bed of fluid.

"Three small veins crossed from the external surface of the temporal lobe to the orbital tissue piercing the dura en route. They were doubly ligated with silver clips and divided. With these veins out of the way and the bed of fluid evacuated, the view of the entire anterior and middle fossa was unobstructed. A tremendous anomalous vein lay along the inner side of the middle fossa and outside the dura. It was formed by the confluence of two large veins—doubtless the superior and the inferior orbital veins—which also pierced the dura covering the orbital contents. It doubtless represented an extradural cavernous sinus. Posteriorly, the ultimate destination of the vein could not be traced.

"The left optic nerve was bent to the right, due to the pressure of the large cup of fluid on the tip of the temporal lobe. Search was made for the carotid artery which always stands out conspicuously alongside the optic nerve, but it could not be found. It is interesting that both the internal carotid artery and the cavernous sinus were absent. Knowing that the carotid artery in its transit through the skull passes through the cavernous sinus, I was led to wonder if the absence of the cavernous sinus might not lead to the loss of the internal carotid artery. No attempt was made to disclose the other nerves entering the orbit. The anterior clinoid process on the left side was absent."

Final Results. A slight downward displacement of the eyeball still remained. There was no exophthalmos or pulsation of the eyeball. The eyes focused well. The extra-ocular movements were nearly perfect five months later. There was no diplopia.

The report of Dr. Woods' examination was as follows: "Exophthalmometer readings: Right 19 mm., left 24 mm. The best vision on the right is 20/30; on the left 20/100. There is a slight concentric contraction of the left visual fields though the change is not great. In addi-

tion to the exophthalmos, the left eye deviates downward and inward. A fine vertical nystagmus is present. The optic disc is normal in outline; the physiological cup is a little blurred; the disc is flat with slight overfilling and rather

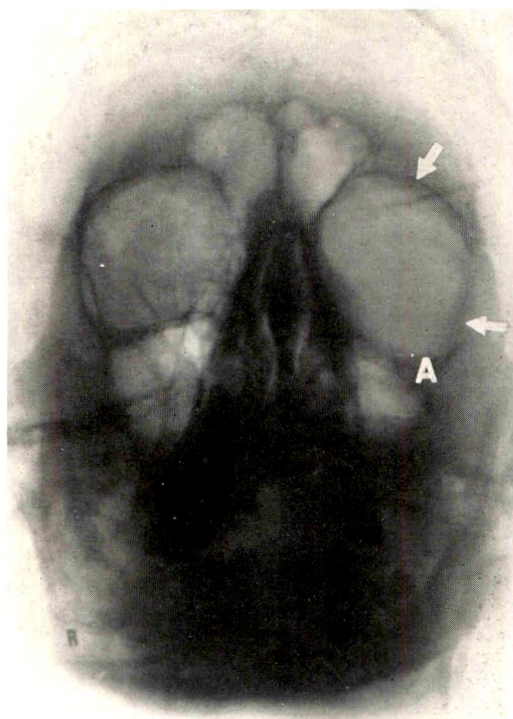


FIG. 6. Case II. Note the absence of bone detail on the left side, and the dropping of the orbital floor, A, and diminished size of the maxillary sinus.

marked tortuosity of the veins. The pupils are equal and react normally to light and accommodation."

CASE II. Male, aged twenty-six, referred to me by Dr. W. W. Griffin, has been under my observation for the past twenty years (Fig. 5). A tumor mass was first noticed along the external surface of the right lower leg in about the mid-portion, without any pain, at about the age of ten years. At the age of fourteen he had his first roentgen examination at the Gibbs Laboratory, at which time his condition was diagnosed as localized gigantism involving the right leg. Another roentgen examination was made at St. Luke's Hospital at the age of twenty-one. On April 27, 1927, I again saw the patient, at which time he complained of pain in the right heel as though something had struck him. The pain started

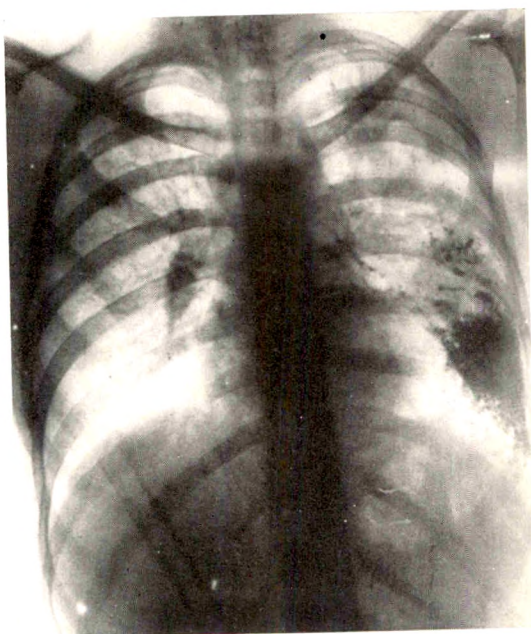


FIG. 9. Case T.A. (Oct. 11, 1927). Cavity now appears in the abscess region. Lipiodol retained in the lower and healthy portion after bronchoscopic injection.

treated and erroneously diagnosed as bronchiectasis elsewhere, in which there was an acute spread of tuberculosis throughout the left lung following repeated bronchoscopies and injections of lipiodol.

Extension of Lung Abscess. The following case of Dr. Helen Gavin demonstrates the acute spread of lung abscess into healthy lung tissue in which injected lipiodol was retained, with a fatal ending.

CASE T.A. A white woman, aged eighteen, with a post-tonsillectomy lung abscess in the upper part of the left lower lobe (Fig. 8), admitted to another hospital, July 22, 1927. Bronchoscopy was performed on August 5, and lipiodol was injected into the left lung for diagnostic purposes. Part of this was retained in the alveoli of the lower and apparently healthy section. Expectoration of much foul sputum continued, lipiodol was again injected bronchoscopically, October 11, and again some of it was retained in the same region (Fig. 9). Here, attended by persisting expectoration and an exacerbation of fever, a secondary abscess rapidly developed to be followed by the appearance of sacculated empyema at the same level (Fig. 10). On December 23, parts of the seventh and eighth

ribs were resected posteriorly, the empyema was evacuated, and the lower lobe was seen to be consolidated and probably gangrenous. The patient died on January 9, 1928.

In another case (J.C.), a Polish laborer, treated at Bellevue Hospital in 1927 and 1928 for a chronic abscess of the lower lobe of the left lung, we believe that the injection of lipiodol through the bronchoscope may have accelerated the spread of the disease.

Comment. The spilling of infectious discharges through the bronchial tubes from ulcerating or exuding cavities or bronchi into previously healthy regions of the lungs is one of the common modes of spread of previously localized tuberculosis or non-tuberculous suppurative disease. The hazard increases as the discharge becomes more copious and more fluid, as, for instance, in hemorrhage. The admixture of additional fluid, such as lipiodol, might be expected, therefore, to provide a more facile vehicle for the transport of infection. In the cases cited strong evidence of this is the undoubted development of new secondary le-

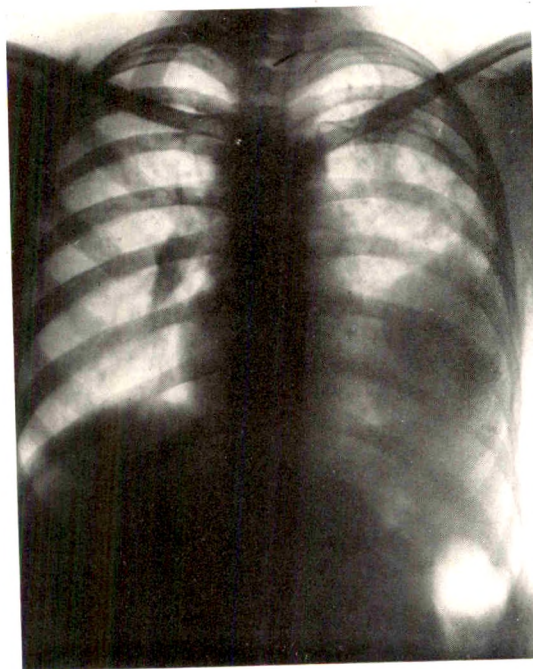


FIG. 10. Case T.A. (Dec. 12, 1927). Secondary abscess and sacculated empyema at the site of retained lipiodol which can still be seen indistinctly.



FIG. 7. Case 11. A. Note the lower position of the eye. B. Neurofibromatosis. Similar lesion on the front of the body. Localized gigantism of the right leg. (See Figs. 5 and 6.) Clinical diagnosis: pulsating exophthalmos.

several days previous to his visit, at which time there was also noticed some swelling. The findings of localized gigantism involving the right leg were confirmed. The peculiar outgrowths on the inner side of the right tibia had increased, but still retained the appearances of a benign bone lesion. To an observer who had not had the advantage of the history of the case, malignancy would immediately be suspected, but the benign nature of the lesion is borne out by the duration of the observation of some twenty years or more. There is also hypertrophy of the soft parts of the leg, this condition not being limited to the region of the bony outgrowths. There is also some hypertrophy of the left fibula with irregularity of outline. The largest outgrowth in the region of the middle of the tibia measures approximately 13 cm. in length and 4 cm. in width. This outline is somewhat oval in shape and has fairly smooth borders. Below this there is an irregular outgrowth measuring about 11 cm. in length and varying from 1 to 3 cm.

in width. The outline of the inner border of this projection shows fairly sharp angulations. However, there is a distinct limitation to the outgrowth and no tendency to the formation of new bone beyond the main growth. The density of the outgrowth is about half that of the shaft of the bone. It is somewhat irregular with the appearance of irregular trabeculations. The entire shaft of the tibia shows increase in density when compared with the opposite side. The entire left leg, including the bones, shows a length amounting in the case of the tibia to approximately 5 cm. greater than the opposite side. The shadow of the middle third of the right leg measures approximately 16 cm. as compared with approximately double that diameter on the opposite side.

It was noticed on physical examination that the left orbit was lower than the right and that there was some pulsation without exophthalmos. Roentgen examination revealed congenital absence of the posterior wall of the orbit on the left side (Fig. 6). This case

sions in apparently healthy parenchyma to which the oil flowed. The reasonable inference is that bacteria-laden pus or mucus from existing lesions mingled with the oil, gravitated with its stream and lodged with it for a sojourn of days or weeks in healthy alveoli. More favorable conditions for the genesis of new lesions here could hardly be imagined. A similar view of this mechanism is entertained by Grill,¹⁶ Archibald and Brown,³ and others, although, as mentioned by the latter, the clinical evidence reported up to 1927 was scanty. Since our selection of cases and technical procedures have been modified on the basis of this knowledge we have had no more accidents of this kind.

Aggravation of Chronic Suppurative Pneumonia; Questionable Atelectasis; Acute Pneumonia; Fatal Hemoptysis. Chronic indurative and suppurative pneumonia, often with bronchiectasis, is a well-known clinical picture. Attacks of fever and increased local symptoms usually signify exacerbations of acute or subacute bronchopneumonia, and this, or some other alarming episode such as hemoptysis, often brings the patient to the hospital. If lipiodol is introduced into the bronchi during one of these phases of active inflammation, there is danger of aggravating the process. This may be slight or serious; transient or progressive. As a sequel, secondary complications, such as pleural inflammation or hemoptysis, may occur. The following cases serve to illustrate.

CASE C.R., a white woman, aged thirty, with symptoms of pulmonary suppuration of four months' duration. On admission, June 8, 1932, the whole right lung was involved in the chronic pneumonia and bronchiectasis. For three months she was treated by bed rest, postural and bronchoscopic drainage. The temperature ranged from 98° to 102° F., and the foul sputum amounted to 5 to 12 oz. daily. On September 8, during a partial remission of symptoms, lipiodol was instilled by the supraglottic method into the bronchi of the right upper lobe. Following this, the temperature gradually rose and the serial roentgenograms showed a persistent clouding

of the right upper lobe, interpreted as increased inflammation. This did not subside and, while the prognosis was always considered hopeless, the reaction contributed somewhat to the later unfavorable course. The patient died December 29, 1932. Autopsy confirmed the clinical diagnosis.

CASE F.G., a white girl, aged fourteen, admitted April 11, 1931. History of recurrent bronchitis with fever since infancy and of chronic cough with 2 oz. of thick greenish, slightly foul sputum since an attack of pneumonia seven years previously. A diagnosis of chronic bronchiectasis of the right lower lobe was made. Lipiodol was injected bronchoscopically into the bronchi of this lobe, April 29, 1931. The bronchogram showed saccular bronchiectasis. A roentgenogram eight days later, revealed a triangular opacity at the base of the right lung in addition to retained lipiodol. Since a chronic inflammation of this type usually results in shrinkage of the affected lobe, the density in question was interpreted as a retention of oil and secretions in the right lower lobe; this seemed to impede proper aeration and there is possibly an element of atelectasis in the picture. The clinical condition was not disturbed and the roentgenographic density gradually cleared during the subsequent five weeks.

CASE D.C., a Porto Rican, male, aged twenty-four, admitted August 17, 1931. Had been in the hospital twice during the previous year. His complaint was the spitting of 2 oz. of blood on each of three occasions, slight cough and slight pain in the left chest. In the hospital his general condition was very good and the only significant symptom was the expectoration of a small amount of mucopurulent sputum, sometimes blood-streaked. There was marked splenomegaly, and old scars on the legs suggested lues although the blood Wassermann test was negative. Physical and roentgen examination showed light fibrotic infiltration of the left lung but no cavity; many small râles throughout. The right lung was clear. Tubercle bacilli could not be found in the sputum, and bronchoscopy was negative. Suspecting the possibility of bronchiectasis, a lipiodol bronchogram was made in July, 1931, but this showed no abnormality. The bronchogram was repeated, September 3, 1931, about 10 c.c. lipiodol being instilled by the supraglottic method so that some entered the descending bronchi of

had previously been examined by an oculist who had apparently missed the deformity and the pulsation.

Examination of the skin showed multiple soft projecting tumors varying in size from a few millimeters in diameter to about 2 cm. in diameter. These are scattered over the front and back of the chest, the buttocks and thighs down to about the lower third (Fig. 7). The arms, forearms, hands and neck also show involvement. These areas would appear to indicate the presence of Recklinghausen's disease or multiple neurofibromata.

Roentgen examination disclosed a congenital deformity of the cervical vertebrae.

In view of recent studies by Dr. Bayard T. Horton of the Mayo Clinic, the gigantism of the lower extremity is regarded as being due to a congenital arteriovenous fistula.

CASE III. Female, aged eighteen, was referred to me on December 12, 1931, by Dr. John M. Wheeler. This case had a pulsating exophthalmos of the right eye (Fig. 8). There was

a tumor mass involving the right upper lid. Roentgen examination revealed an absence of the bony wall at the posterior border of the right orbit. This appearance is practically the same as that observed in two other patients. In addition to the deficiency in the posterior wall there is also deficiency in the superior and also in the external wall of the right orbit. This case also had an extensive pigmented birthmark extending over both buttocks and back and thighs.

CASE IV. Female, aged nine, was referred to me on August 25, 1932, by Dr. John M. Wheeler. When the patient was $4\frac{1}{2}$ years old she had infantile paralysis and the mother noticed that the entire right side of her face seemed to droop and the right eye protrude (Fig. 9). Pulsation of the eyeball was noted and the patient was then seen by Dr. Wheeler, who made a diagnosis of pulsating exophthalmos. After studying the other cases in which there was a congenital absence of the superior orbital wall a survey of the records

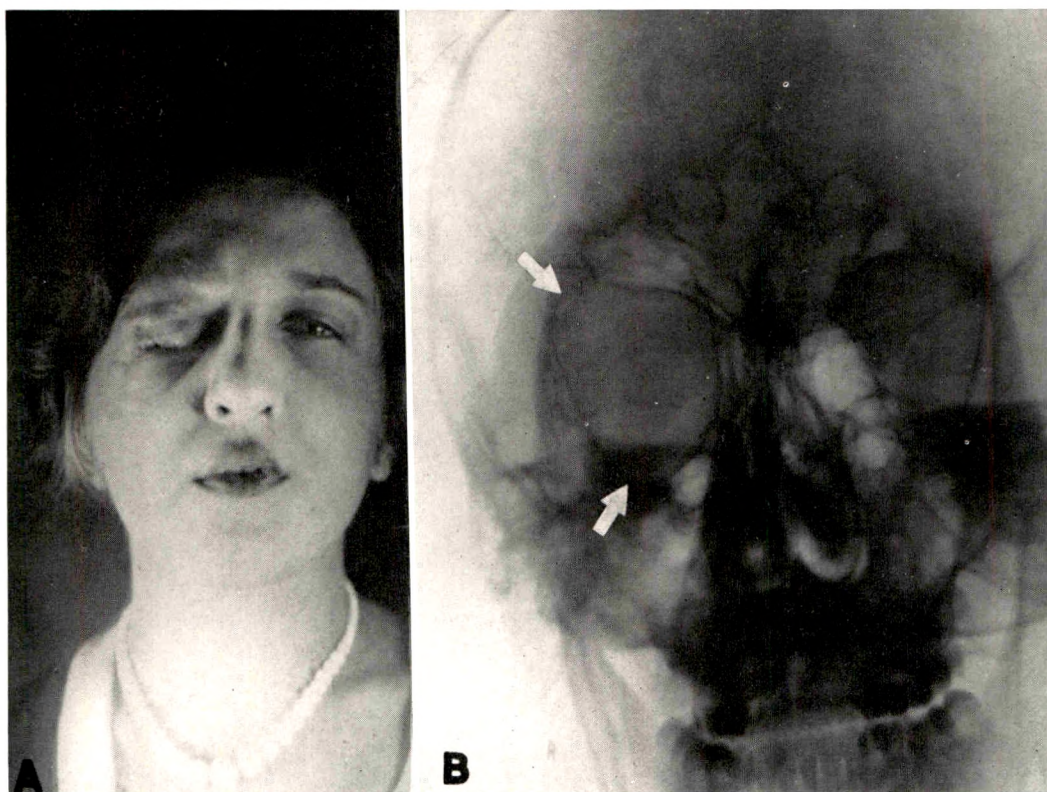


FIG. 8. Case III. A. Pulsating exophthalmos, right eye, associated with neurofibromatosis of lid and other regions of body. B. Note absence of the superior orbital wall, right side, associated with lower position of the inferior wall and smaller maxillary sinus than on the other side. (Courtesy of Dr. John M. Wheeler.)

both lungs. The temperature, previously normal, rose to 100° F. during the next few days; starting September 11, it became more elevated each day until it reached 105.8° F. September 14. Then it slowly receded and did not rise above 100° F. from September 21 until October 7, when the patient was discharged. At the height of the fever, signs of dullness, bronchial breathing and many moist râles were elicited over the left lower lobe, and the roentgenogram of September 16 showed the density of acute pneumonia in the lower half of the left chest. The blood leucocyte count, September 17, was 16,200. During the attack and its recession the sputum was copious, mucopurulent and slightly foul. The last roentgenogram of September 26, showed much clearing but this was not yet complete.*

CASE J.L. The patient, a white man, aged fifty, was in the hospital from September 23 until October 11, 1930. He was considered to have chronic pneumonitis and bronchitis with a recent exacerbation of bronchopneumonia in the left lung. The sputum was occasionally blood-streaked but not foul. The temperature ranged up to 101.4° F. Before the acute inflammation had completely subsided lipiodol was instilled into the left lung. No bronchiectasis was demonstrated and the patient went home the following day, October 11. Four days later he returned with a temperature of 103° F., increased cough and expectoration, and pain in the chest. He was found to have bronchopneumonia on the left; and a small amount of reddish fluid was aspirated from the left pleural cavity. Almost the entire lung became consolidated as shown by physical and roentgen examination. There was no empyema; 25 c.c. of thin reddish fluid, aspirated from the left pleura, November 11, yielded no growth on culture. The white blood count, October 15, was 21,000, 90 per cent polymorphonuclears; October 16, 13,500, 84 per cent; November 11, 10,600, 82 per cent. The patient's condition became steadily worse and he died November 17.

CASE S.C., admitted August 28, 1929, a white man, aged forty-nine, who fell sick in July

with a profusely productive cough and loss of weight and strength. On admission he was coughing up about 9 oz. of slightly foul, sweetish smelling, mucopurulent sputum daily. The diagnosis was suppurative pneumonitis at the base of the right lung, possibly with bronchiectasis. Bronchoscopy, September 20, showed pus coming from the right middle and lower lobe bronchi. The temperature varied from 97° to 100° F. On September 25, about 20 c.c. lipiodol was instilled by the supraglottic method. Most of this entered the right lung but a small amount went into the left lower lobe also. No bronchiectasis was demonstrated. After this there were occasional rises of temperature up to 101.8° F. On October 11, he had marked dullness, bronchial breathing and numerous râles at the posterior base of the right lung and similar but less marked signs at the left base posteriorly whereas, on admission, only slight bilateral basal dullness and a few râles at the right base were elicited. The roentgenogram of October 22 shows a good deal of retained lipiodol at the right base, with a surrounding exudative reaction; also a suggestion of diffuse inflammation at the left base. The sputum continued to be foul and copious. The evidence was interpreted as indicating an acute exacerbation of the suppurative pneumonia. On the night of October 28, the patient had a sudden paroxysm of coughing and a hemoptysis of 2 oz. He lost consciousness immediately and died within an hour. Apparently, the immediate cause of death was the inundation of the lungs with blood, most of which could not be expelled.

In our series there is another case in which extensive saccular bronchiectasis of the right lower lobe was proved and in which lipiodol instillation was possibly a factor in aggravating the suppurative process, thus precipitating a large hemoptysis. This was controlled and the affected lobe was later removed surgically.

Comment. With the evidence of these cases, there can be no doubt that instilled lipiodol may precipitate a more or less acute inflammatory reaction in an existing suppurative lesion and probably in other smoldering infections as well. We are among those who suspect that this pneumonic complication is a more common experience than the literature reveals. According to Morvay²⁷ who discusses the question, Piccenino, in 1927, was the first

* Later, in another hospital, another lipiodol bronchogram was made. On August 22, 1933, the patient returned to Bellevue with definitely active tuberculosis in both lungs, and he died from this September 15, 1933. The autopsy revealed fibroid tuberculosis of the left upper lobe with cavity, extensive tuberculous excavation of the left lower lobe and fresh bronchopneumonic lesions in the right lung. The case is recorded because of the pneumonia following lipiodol instillation which apparently had no relation to the subsequent activation of the tuberculosis.

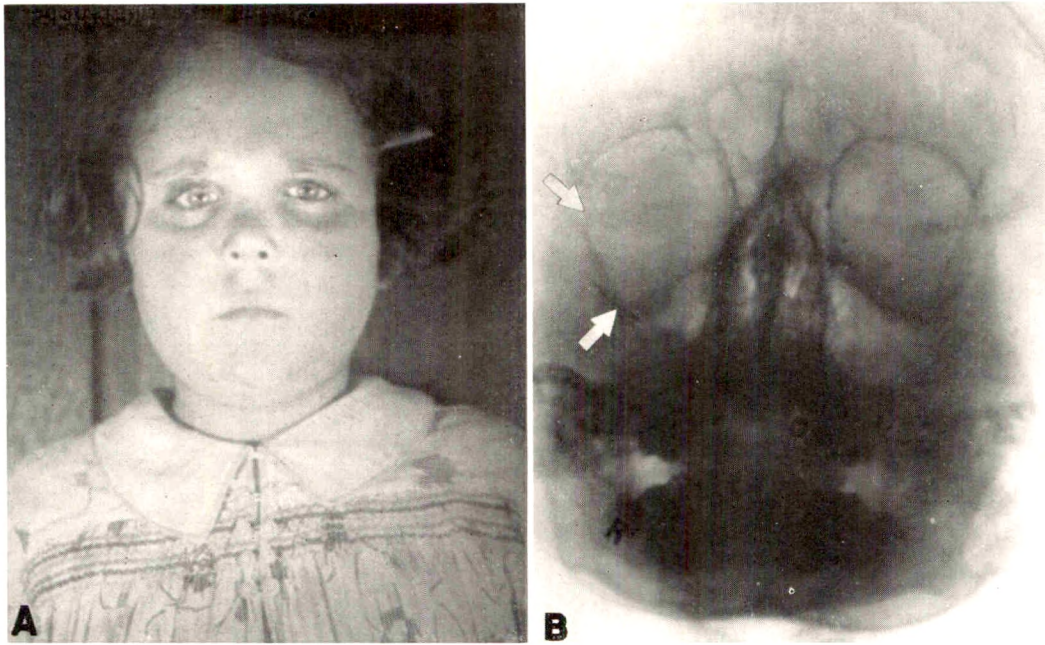


FIG. 9. Case IV. Congenital absence of the superior orbital wall, right side. A. Note exophthalmos of the right eye. Clinical diagnosis: pulsating exophthalmos. B. Note the absence of the posterior superior orbital wall, right side, associated with lower position of the inferior wall and smaller maxillary sinus than on the other side. (Courtesy of Dr. John M. Wheeler.)

of cases previously diagnosed as pulsating exophthalmos resulted in having the patient



FIG. 10. Pulsating exophthalmos reported by Moore. No roentgenogram published, but case is apparently one of congenital absence of the superior orbital wall.

return for roentgen examination which confirmed the fact that there was a congenital absence of the superior orbital wall. No other anomalies were noted in this case and no evidence of Recklinghausen's disease has yet manifested itself. There is definite deformity apparently of congenital nature involving the right orbital wall. There is evidence of deficiency in both the superior and lateral portions of the wall. The inferior portion is also partly deficient and is lower than the opposite side. This has resulted in a much smaller antrum on the right than on the left. Lateral exposure shows an apparent absence of the anterior clinoid processes. The diploic channels are very large. The convolutional markings are more prominent especially in the occipito-parietal region.

There are several cases reported in the literature in which pulsating exophthalmos was not definitely recognized as being due to a congenital defect in the superior orbital wall (Fig. 10). In some of the cases, however, roentgenograms are published showing this condition (Fig. 11). Other cases are referred to in the literature in which

to report a case. It is also considered seriously by Bonnamour, Badolle and Gaillard and by Archibald and Brown. The latter have presented a most helpful paper on such dangers and suggest that these are explainable on the basis of several factors—plugging of small air passages and interference with drainage, retention of lipiodol with resulting congestive reaction, and carrying down of additional infection from the mouth or throat. The first two of these seem to be the more important. Once initiated, an inflammatory reaction may be uncontrollable, as shown by our fatal cases. The fatal hemorrhage in Case S.C. most probably was due to rapid pulmonary necrosis and ulceration. Forestier and Quentz¹³ observed a similarly fatal hemorrhage, and Grill¹⁶ had a patient with bronchiectasis who died from an acute suppurative process following lipiodol instillation.

Incidentally, lipiodol does not possess sufficient antiseptic power to stop the growth of bacteria in the lung. Neuswanger and Brown (cited by Archibald and Brown) showed this. Amako¹ found that 20 per cent iodipin exerts no significant lethal effect upon tubercle bacilli in the test tube, and kills pyogenic and intestinal bacteria only after many hours of contact. Forestier and Quentz hold a somewhat similar view, but on the basis of experiments with rabbits think that the antiseptic action may be greater in the living subject.

Prevention of serious consequences of oil injection depends on strict regulation of the procedure as we are discussing below.

DANGERS FROM INTERFERENCE WITH CARDIAC AND RESPIRATORY MECHANISMS

Cardiac Weakness. In patients in whom myocardial weakness from any cause is apparent or suspected, the bronchial instillation of lipiodol may cause dyspnea. In 3 such cases, known to us, this symptom was somewhat alarming.

Pulmonary Fibrosis and Emphysema. Cases of pulmonary fibrosis and emphysema, often associated with a secondarily

overtaxed heart, may react in the same way. In this category we have one fatality to report.

CASE J.W., admitted December 1, 1931; a white man, aged sixty-four, who complained of dyspnea of two years' duration, becoming worse of late. He had lost 30 pounds in weight, had had occasional attacks of vertigo and fainting during the preceding three weeks, and felt weak. He had had hay fever for many years,

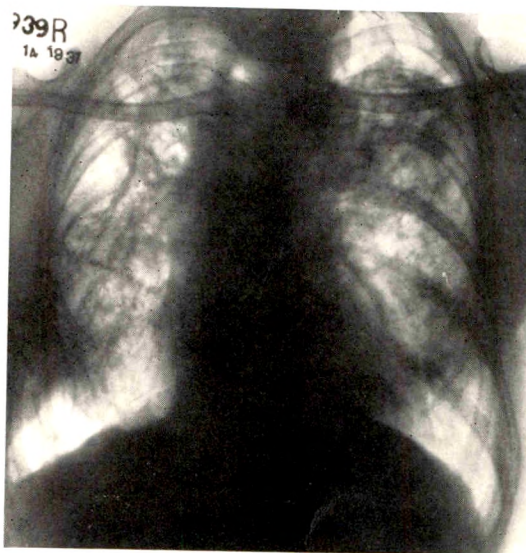


FIG. 11. Case J.W. Advanced bilateral pulmonary fibrosis and emphysema and possible bronchiectasis.

sinusitis forty years previously, and rheumatic fever in childhood, and drank alcohol to excess. On admission he appeared undernourished and chronically ill, and was slightly dyspneic and cyanotic. The chest was barrel-shaped and revealed these other signs: Right—Slight dullness throughout. Breath sounds harsh just below the clavicle. Many crepitant and a few moderately coarse râles throughout. Left—Slight dullness and crepitant râles in the middle third. The roentgenogram of December 11 (Fig. 11) showed widespread bilateral pulmonary fibrosis and emphysema associated with more or less round rarefactions varying up to 5 cm. in diameter which suggest bullous emphysema and possibly some bronchiectasis. The heart seemed slightly enlarged to the right, and the sounds were distant. The brachial arteries were moderately sclerotic and slightly tortuous. The liver was not enlarged but its lower border was

the eye has been removed and no tumor found. Moore² reports as follows:

"Rockliffe and Parsons published a case in which the patient, a child of two, died after exenteration of the orbit preceded by ligation of the carotid artery (Trans. Path. Soc., 1903). In their case the whole of the bone of the orbit except the floor and outer wall had disappeared, or *I suspect had never developed*, so that the growth was in direct continuity with the cranial cavity, a fact which no doubt was responsible for the pulsation." (Italics mine.)

In another case the carotid artery was ligated in the belief that the orbital mass was of a vascular nature.

Schüller⁴ reports a case as follows:

"H., male, twenty-eight years of age. Trauma of the head in early youth. Deformity of the skull and face from early childhood. At the time of examination

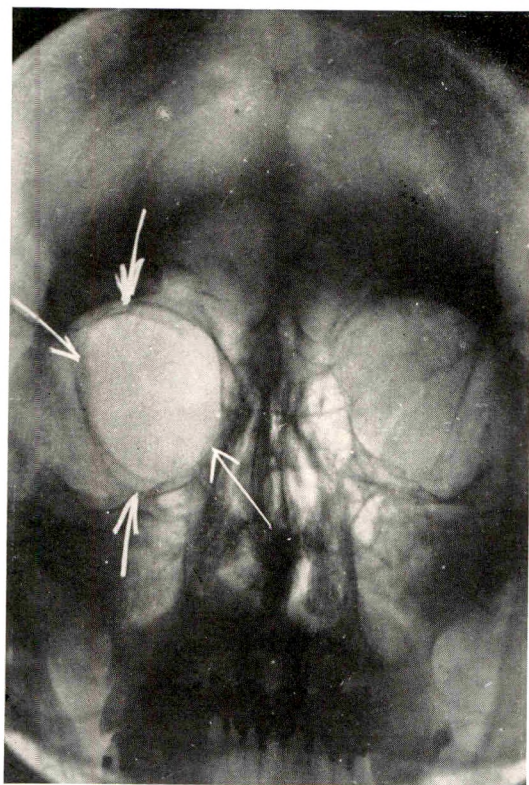


FIG. 11. Roentgenogram of a case which Dr. M. J. Hubeny has been good enough to send me and which shows the absence of the superior and posterior orbital wall as indicated by the arrows.

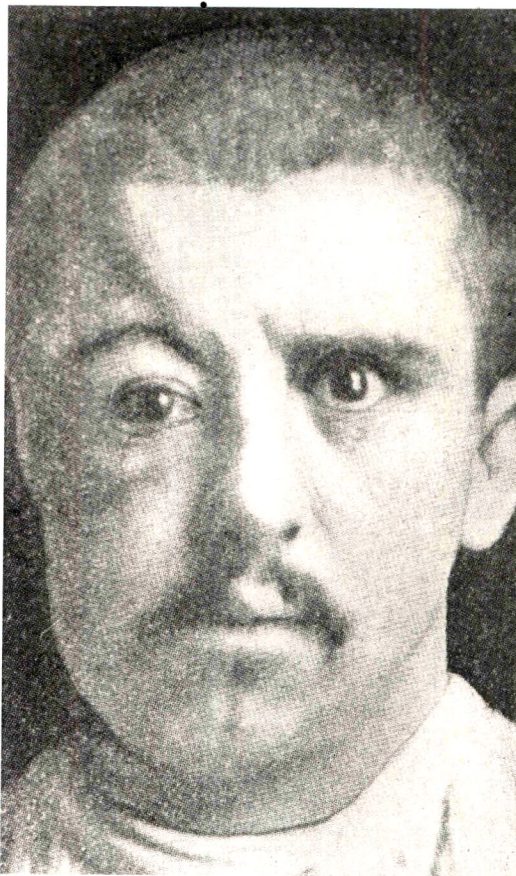


FIG. 12. Schüller's case. Pulsating exophthalmos of right eye, associated with absence of upper and posterior portions of the orbital wall, assumed to be due to lymphangioma, but which, in my opinion, may be due to a congenital defect.

there was an exophthalmus pulsans. It was possible to push the eye back. There was bulging of the right temporal region, and thickening of the tissues of the right side of the face, resembling elephantiasis.

"The roentgen examination permitted one to see that the upper and posterior portions of the orbit were gone. The wall of the skull, corresponding to the right temporal region, appeared thinned, bulged outward, and rarefied by the presence of numerous vascular canals. The floor of the right middle cranial fossa was lower than the left. The sella turcica was shallow and widened at the top. Taking into consideration the change in the facial skin, a lymphangioma was assumed as the cause of the symptoms. It is probable that the circumscribed destructive changes in the orbital wall, the skull base, and the temporal region were produced by a portion of the lymphangiomatous tumor, lying intracranially." (Italics mine.) (Fig. 12.)

palpably irregular, hard and slightly tender. The fingers and toes were clubbed. The sputum was mucopurulent, about 2 or 3 ounces daily and negative for tubercle bacilli. The urine showed a trace of albumin and a few hyaline and granular casts. Analysis of the blood serum showed 33 mg. nonprotein nitrogen, 15.6 mg. urea nitrogen, 1.4 mg. creatinine, and 87 mg. glucose in 100 c.c. The temperature fluctuated from 98° to 101° F., but this and the dyspnea, as well as the general condition improved markedly after three weeks' rest in bed. On December 24,

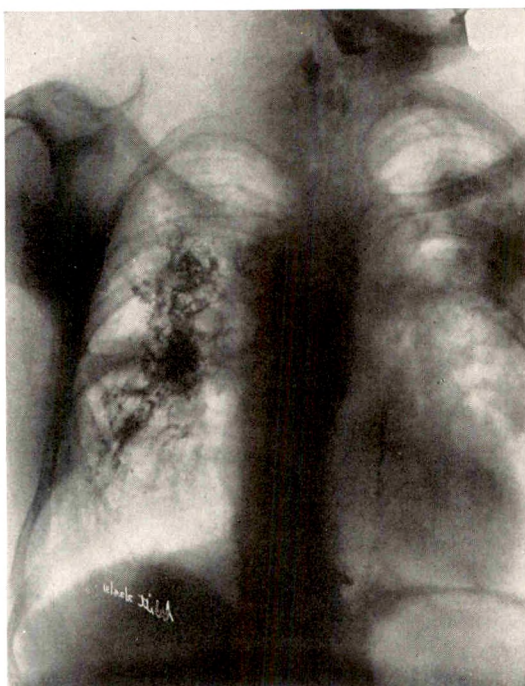


FIG. 12. Case J.W. (Dec. 24, 1931). Roentgenogram made after the patient had collapsed and died following the instillation of lipiodol.

in preparation for a bronchogram, the patient was given a postural drainage, and the following medication (a much heavier dosage than we are accustomed to give) was administered on the order of the house physician: sodium amytal gr. 3, by mouth; codeine sulphate, gr. $1\frac{1}{2}$, and atropin sulphate, gr. $\frac{1}{33}$, by hypodermic. An hour later the house physician took the patient, who was sleepy, in a wheel chair a short distance to the roentgen room, where the pharynx was sprayed with 4 per cent cocaine solution and between 5 and 10 c.c. lipiodol was instilled by the supraglottic drop method into the bronchi. The patient then stood before the

roentgenoscope and in a few minutes collapsed. The pulse was irregular and weak, and the patient became very cyanotic and dyspneic. The administration of stimulants and oxygen inhalations did not help, the pulse became very slow and weak and, without regaining consciousness, the patient died within an hour. A post-mortem roentgenogram showed scattered lipiodol shadows in both lungs (Fig. 12).

Comment. A combination of factors was responsible for this patient's death. Under rest treatment his failing heart had regained itself somewhat but obviously not sufficiently to withstand strain. While the preliminary medication was given in large doses this did not seem to be the lethal factor. The exertion attendant on lipiodol instillation and roentgenoscopy must have been too much. Finally, the respiratory surface, already greatly diminished by extensive fibrosis and emphysema, must have been further depleted by the oil filling some of the bronchioles. In our judgment, the heart failed from these causes.

Asthma and Asthmatic Bronchitis. Disturbing effects have been noted by us in patients with asthma and asthmatic bronchitis. R.K., a woman, aged twenty-nine, with chronic asthmatic bronchitis and emphysema had a severe paroxysm of dyspnea and wheezing after the instillation of only 2 or 3 c.c. of lipiodol into the trachea. G.T., an outpatient, a girl, aged seventeen, who had had asthma and bronchitis since childhood resulting in the development of moderate pulmonary emphysema, experienced a similar immediate attack with low fever during two days after the instillation of 10 c.c. of lipiodol.

Comment. Since, in allergic persons, an asthmatic attack may be provoked at times by indifferent as well as specific agents, it is reasonable to expect that with iodized oil instillation severe bronchospasms might be induced. Complicating emphysema and chronic catarrhal inflammation may perhaps heighten this tendency. While the consequences may not be serious, the fatality reported by Macdonald²⁶ indicates at least that potential dangers must be recognized.

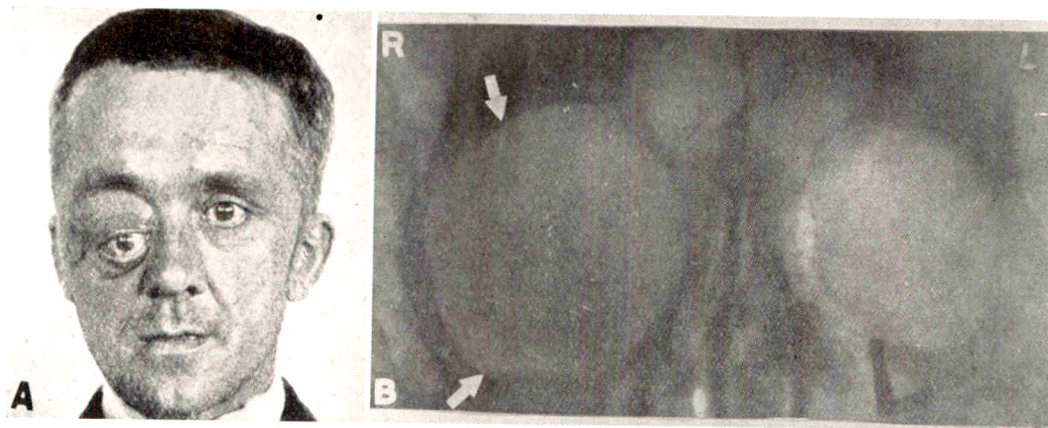


FIG. 13. Moore's case. A. Pulsating exophthalmos, right eye. Ligation of carotid artery, but pulsating and protrusion continued, neurofibromatosis also present. B. Roentgenogram shows deficiency of posterior orbital wall and larger orbital cavity on the right side. This case might easily have been mistaken for sarcoma.

Moore also reports a case in which ligation of the carotid artery was performed, but no definite aneurysm was found and the exophthalmos continued. This case was also associated with neurofibromatosis, similar to that observed in one of my cases (Case II) and also in one of the cases referred to me by Dr. Wheeler (Case III). (Fig. 13.)

SUMMARY

1. Congenital absence of the superior orbital wall causes pulsating exophthalmos. The condition is easily distinguished roentgenologically from sarcoma of the orbit, especially in view of the fact that there is usually deformity of the floor of the orbit in addition to the other bony changes. The inferior margin of the orbit may be lower than the corresponding region on the normal side.

2. Four cases of congenital absence of the superior orbital wall are reported. In one case the diagnosis has been confirmed and a new orbital wall constructed by a bone transplant from the skull. (Dandy.)

3. Two of the cases had associated lesions due to the presence of diffuse neurofibromatosis (Recklinghausen's disease).

4. One case, in addition to the associated Recklinghausen's disease, had a congenital arteriovenous fistula of the right leg, causing localized gigantism, and also had a congenital deformity of the cervical spine.

5. In the routine examination of roentgenograms of the head it is advisable for the roentgenologist to study carefully the

bony outline of the orbits, in addition to a study of the nasal accessory sinuses.

6. Enucleation of the eye, or ligation of the carotid artery, should never be performed in a case of pulsating exophthalmos, unless a roentgen examination has been made and shows no evidence of congenital absence of the superior orbital wall.

NOTE: Just prior to publication, the importance of a roentgen examination and proper interpretation prior to the removal of an eye are made more imperative due to a recent court decision whereby the parents were ordered by the court to have the child's eye removed for a tumor. This decision was made about April 19, 1933, in the case of a two-year-old girl over the protests of her parents, by a judge in the children's court, and was sustained by the Appellate Division of the Supreme Court in Brooklyn, New York, five justices concurring in adjudging the baby to be a "neglected child" and in holding that the State has an affirmative control over the child's physical welfare under the 1922 children's court act. In this particular case the tumor was stated to be due to a glioma and the eye was removed fortunately before invasion of the optic nerve had occurred. But, had the case been one of pulsating exophthalmos and the eye needlessly sacrificed, both the medical and legal profession would have been subject to criticism.

REFERENCES

1. HORTON, B. T. Hemihypertrophy of extremities associated with congenital arteriovenous fistula. *J. Am. M. Ass.*, 1932, 98, 373-379.
2. MOORE, R. F. Diffuse neurofibromatosis with proptosis. *Brit. J. Ophth.*, 1931, 15, 272-279.
3. ROCKLIFFE and PARSONS. *Tr. Path. Soc. Lond.*, 1903.
4. SCHÜLLER, ARTHUR. Roentgen Diagnosis of Diseases of the Head. Trans. by Stocking. C. V. Mosby Co., St. Louis, 1918, p. 262.

This was the case of a thirteen-year-old girl, who experienced nausea and vomiting after the lipiodol injection, became cyanotic and weak-pulsed and died in twenty hours. Commenting, Macdonald says: "This child had suffered from asthmatic attacks for many years, and it should be noted that sensitization tests, carefully carried out, indicated that she was hypersensitive to several types of allergens. In conformity with this, it is a reasonable conjecture that her death was due to an allergic reaction to lipiodol." It is probable that the pleural fibrosis and the chronic pulmonary and bronchial changes, as well as the congestion, edema and tenacious bronchial secretion found at autopsy contributed to the final disaster. Anderson,² on the other hand, reports treating 100 cases of bronchial asthma by intratracheal injections of lipiodol, usually with ultimate benefit. He advises caution, however, since in some of his cases the first injection precipitated an immediate attack. In others "there are certain untoward reactions characterized by pain, pressure and temperature."

Bronchial Occlusion. In a number of cases in which a bronchus was occluded by a growth we have used lipiodol for bronchography. Cautiously instilling less than 10 c.c. we have observed no ill effects. Singer³⁷ of Vienna, however, reports a fatality in a case of carcinoma of the right lower lobe bronchus and compares it with a similar accident reported by Trommer. Singer considers the part that might have been played by the anesthetic, but believes that the manner of death most strongly suggests suffocation. It is, indeed, easy to visualize this. If the ventilation of one or more lobes is already reduced or prevented by such an obstruction, the introduction of oil into functioning bronchi must certainly further deplete the respiratory surface, and if this is sudden and extensive beyond physiological limits, the symptoms of Singer's patient—shock, tonic and clonic convulsions, intense cyanosis, dyspnea, unconsciousness and death—might be expected as evidence of acute asphyxia.

USES OF LIPIODOL FOR BRONCHOGRAPHY

In spite of these disadvantages and dangers, the procedure is still to be regarded as an invaluable aid for the diagnosis of various chest conditions. By attempting, as we have done above, clearly to visualize the causes and mechanisms of possible accidents we can with assurance of great success adopt means to avoid most of them. In fact, during the year 1932 and thus far in 1933, we have had no serious accidents or complications and no fatalities from this cause. Without discussing details of lipiodol bronchography which are familiar parts of the literature on the subject, we shall present briefly the general principles governing selection of cases and technique which we have tested and found sound.

Primarily it is important that the case have a thorough preliminary clinical study. This includes, in addition to the history and physical examination, roentgen examination of the chest, repeated sputum examinations with concentration methods, and in some cases bronchoscopy. As a rule, it is much better for the patient to enter the hospital for such study. For this reason and because of occasional untoward reactions the procedure cannot be used as freely in the outpatient clinic or the private office.

The clinician, who has studied the case and knows specifically what further information is needed, should perform the lipiodol instillation or at least closely direct it. There is, of course, no reason why a laryngologist or any other qualified physician should not do this if he works with full understanding of the individual problem, but the procedure certainly does not belong exclusively in the "nose and throat" specialty. Our practice is to train all our resident physicians to perform their own lipiodol instillations.

Bronchography should be done when it is important to verify the clinical diagnosis, to supplement it with additional information, or to make a diagnosis which may be surmised but impossible to establish otherwise. From 3,500 to 3,800 patients pass through our ward service in Bellevue Hos-

PITUITARY ADENOMAS*†

By ROBERT C. MOEHLIG, M.D.

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THE fact that roentgenologists are frequently called upon to treat endocrine disorders is justification for presenting certain phases of endocrine problems. Particularly in pituitary and ovarian disturbances, the aid of the roentgenologist is frequently sought for treatment. It is in this type, which frequently leads to amenorrhea in the female and impotency in the male, that the roentgenologist must be on his guard. Not infrequently the patient feels that the roentgen treatment caused the amenorrhea or impotency, not knowing of course that the condition for which she was treated was the real cause. The patient should be told before treatment is instituted that the endocrine disturbance for which she is being treated may lead to amenorrhea and sterility.

Quite recently I saw a case of a girl who had been working in the office of a roentgenologist for twelve years and had developed amenorrhea. Because of her association, she knew that the roentgen ray was used to produce this in certain conditions and was inclined to place the blame for her amenorrhea on the roentgen ray.

While the diagnosis rests upon the referring physician and is not the immediate concern of the roentgenologist, still no harm will be done in showing a few of the pituitary conditions which lead to changes in the sex glands.

The pituitary cells are classified according to their staining qualities as follows:

- (A) The chromophobe or chief cells which take stains rather poorly.
- (B) The eosinophil cells which have an affinity for the acid eosin.
- (C) The basophil cells which have an affinity for the basic stain.

The chromophobe cells are believed by many to be the mother cell of all pituitary

cells; they constitute about 52 per cent of all the cells. The eosinophils average around 37 per cent, whereas the basophils make up the balance of 11 per cent. These figures are



FIG. 1. Case 1. Chromophobe adenoma in a male showing inversion of sex characteristics.

naturally approximate and many variations of this number are found.

When adenoma formation takes place in these cells, they give rise to a fairly characteristic syndrome. Each cell type produces a syndrome that can usually be recognized clinically.

The first type, the chromophobe adenoma (Fig. 1), makes its presence known by local pressure signs and a regression of physiological activity or, in other words,

* Of the three adenomas used to illustrate this article two (Cases I and III) have been published elsewhere (*Endocrinology*, 1929, 13, 529-532; *J. Am. M. Ass.*, 1932, 99, 1498-1500).

† Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Michigan, Sept. 27-30, 1932.

pital each year. About 80 to 85 per cent of these are tuberculous, the remainder being grouped under a large variety of diagnoses. Lipiodol bronchography is performed in less than 1 per cent of the tuberculous cases and in 10 to 15 per cent of the non-tuberculous ones.

Bronchiectasis. In this condition the diagnostic use of iodized oil is of greatest importance. When the clinical picture is definite, bronchography is of service in accurately fixing the site and extent of the involvement. In treatment this information is advantageous, and, if the treatment is to be surgical, quite indispensable. If, for instance, the surgeon contemplates lobectomy, accurate localization of all the main ramifications of the disease is fundamental to a decision.

For the diagnosis of "dry," sometimes hemoptoic forms of bronchiectasis, lipiodol bronchography possesses a unique advantage, as first shown by Bezançon and his coworkers.⁵ These patients have only a small amount of mucoid, slightly foul or odorless sputum, sometimes intermittently, or none at all. Some come to the hospital because of hemoptysis, which may recur at intervals of months or years. First of all, tuberculosis must be ruled out. The roentgenogram usually is clear or only suggests some fibrosis. Then, bronchography may demonstrate a well-marked, usually cylindrical bronchiectasis which gives rise to no definite physical signs or perhaps just a few localized râles most often at the base of a lung. Before the use of bronchography, these patients were often thought to have "occult tuberculosis" and many spent months "curing" in sanatoria. Some, unfortunately, still do.

Lung Abscess. As illustrated with case reports there is an element of danger in introducing lipiodol into the bronchi in the acute stage of lung abscess. Because of occluding edema or granulation the oil may fail to enter and delineate the abscess. It is rarely, if ever, necessary to resort to bronchography for the diagnosis of this condition, and, once diagnosed, the abscess can

usually be localized accurately by other clinical and roentgen methods. In the healing stage, however, when the acute inflammation has subsided and the abscess has "dried up," leaving only some fibrosis, lipiodol may be introduced with safety and advantage. In this way we have found residual cavities or bronchiectasis in some cases in which symptomatic healing was complete following medical or surgical treatment and in which other physical and roentgenological methods of examination gave little or no clue to the presence of these remnants. Such information is of importance in helping to determine what advice should be given the patient about his future course.

Bronchial Tumors. Neoplasms springing from small bronchi or situated in upper lobe bronchi are often not visualized by the bronchoscopist. Occasionally, in such cases a lipiodol filling defect has given us our first proof of a bronchial obstruction. The accidental discovery of such a defect in 2 of our cases previously considered to be bronchiectasis resulted in the finding of carcinoma. Coating the trachea and bronchi with the oil has proved helpful at times in determining the location and degree of distortion and compression from the pressure of extrinsic tumors such as retrosternal thyroid and aneurysm.

Tuberculosis. In a very few cases of tuberculosis bronchography may be indicated. Thus, in clinically healed disease with persisting sputum and possibly slight blood-spitting, the procedure may demonstrate complicating bronchiectasis. This is more common in extensively fibroid tuberculosis, and the dilated bronchi are sometimes visualized with the oil even after thoracoplasty. Some employ the method to prove the presence of and outline cavities otherwise hidden by surrounding fibrosis and thickened pleura. But the occasions for this need are few indeed. If ordinary physical and roentgen examination do not suffice for the purpose, stereograms, oblique and lateral roentgenograms, sometimes taken with a screen grid, roentgenoscopy, and possibly a diagnostic pneumothorax or



FIG. 2. Case 1. Roentgenogram showing very large sella turcica with erosion (chromophobe adenoma).

hypofunction. The tumors often reach a very large size before making their presence known. The roentgenogram usually shows a very large sella (Fig. 2). The chromophobe adenoma with hypofunction, or so-called dysfunction of the pituitary, may be compared to the colloid goiter with myxedema. In other words, the chromophobe seems to be the resting stage of the pituitary cell.

In the male, there is impotency with atrophy of the testicles and loss of secondary sex characteristics. Not infrequently they take on female characteristics so that they no longer shave due to lack of beard growth, the pubic hair assumes the triangular shape of the female and the skin is soft like that of the female. Gynecomastia may also be present (Fig. 1).

In the female, there is amenorrhea from lack of pituitary stimulation to the ovary and consequent failure of follicle ripening.

Some of the other findings in the chromophobe variety are: increased sugar tolerance; low blood pressure; secondary anemia; obesity and polyuria. These are in addition to the local pressure manifestations.

The second type, the eosinophil adenoma, gives rise to the well-known syndrome of acromegaly (Fig. 4). Here we have en-

largement of the skeletal system and viscera. Kyphosis due to osteoporosis of the spine is usually present. A decreased sugar tolerance with glycosuria and hyperglycemia is found in a high percentage of cases. Masculinization of the female with hypertrichosis of face, arms and legs; male distribution of hair; deep bass voice and amenorrhea are usually present. Hypertension and atherosclerosis are a part of the picture. Polycythemia may also be present; connective tissue and fatty tumors are not infrequent.

Of interest is the fact that eosinophilism or acromegaly almost always occurs in the brunette and the individuals developing this disease take on the physical characteristics of the negro. The roentgenogram usually shows an enlargement of the sella turcica.

The third type of pituitary adenoma is the basophil adenoma, which results in the condition termed basophilism and which was recently described by Cushing¹ (Fig. 5).

¹ Cushing, Harvey. The basophil adenomas of the pituitary body and their clinical manifestations (pituitary basophilism). *Bull. Johns Hopkins Hosp.*, 1932, 50, 137-195. Further notes on pituitary basophilism. *J. Am. M. Ass.*, 1932, 99, 281-284.



FIG. 3. Case 1. Under surface of the brain showing chromophobe adenoma.

bronchoscopy usually yield all the information that is required for diagnosis and for the various forms of therapy, especially collapse treatment—and without the hazard that attends the instillation of oil. Almost all workers are agreed that the oil should not be used in febrile or hemoptoic stages of tuberculosis. We go further and, for reasons stated, warn against its use in any of the exudative or caseating forms of the disease, particularly if there is much sputum. It is relatively safer to use it in the fibroid or fibrocavernous forms if the sputum is scanty or does not contain tubercle bacilli.

Miscellaneous Uses. Occasionally we have found lipiodol roentgenograms of value in distinguishing extrapulmonary from pulmonary collections of fluid or gas. In several cases it has helped to identify the site and presence of bronchopleural fistulas. It is often useful in tracing the course of other sinus and fistulous tracts. For instance, we had a case of upper thoracic spinal caries with an abscess presenting an opening in the anterior cervical triangle. After injecting lipiodol into this fistula to determine the extent of the abscess cavity, the roentgenogram showed deposits of the substance in both lungs, proving an unsuspected communication with the trachea or bronchi.

Special Contraindications. On the evidence presented we consider it bad practice to instill lipiodol into the bronchi of patients who have obviously weak myocardiums because of the dyspnea and pulmonary edema which may result. In patients with extensive emphysema and pulmonary fibrosis it should be used with great caution, and not at all if there has been evidence of secondary cardiac failure. Asthmatics, particularly the chronic ones, should be managed carefully; as a rule we try to get along without bronchography in these cases. In any case, the presence of an acute or subacute inflammation of the lungs or bronchi, with or without fever, is a contraindication and the procedure should be postponed until the inflammation has subsided. In cases of hyperthyroidism iodized oil probably should not be used since the iodine,

liberated from the swallowed oil, may do harm; brominized oil has been advised by some as a substitute. At all times the selection of cases should be guided by discretion and judgment with regard to the patient's general condition and individual peculiarities.

TECHNIQUE

We describe here only the methods which we have used. They are simple and satisfactory. There are numerous modifications recorded in the literature.

Preparation of the Patient. An hour before introducing the lipiodol it is advantageous in most cases to give by mouth codeine sulphate, gr. $\frac{1}{2}$ to 1, and sodium amytal, gr. 3. Occasionally, atropine sulphate, gr. $\frac{1}{100}$, may also be given if the bronchial secretion is profuse. With this preliminary medication the patient is quieter and less likely to cough, and the flow of oral and bronchial secretions is inhibited. To guard against the aspiration of infectious material from the mouth, the patient should brush his teeth with sodium perborate or some other suitable preparation. If the amount of sputum is considerable, and especially if it arises from a lesion in the lower part of the lungs, the patient should drain his bronchi by hanging over the edge of a bed or table, head and shoulders down, for ten to twenty minutes. This clears the passages for better lipiodol filling and helps prevent coughing and overflow of infectious secretions into healthy sections of the lungs during such filling. The actual injection is best done in the roentgen room so that it can be controlled roentgenoscopically and roentgenograms can be taken immediately. Transporting the patient to the roentgen department after the injection and allowing more than a few minutes to intervene before the roentgenograms are taken is almost sure to impair the quality of the bronchograms because of the scattering and too deep penetration of the oil.

Topical Anesthesia. With the preliminary medication suggested it is sometimes un-

This type is characterized by "a rapidly acquired, peculiarly disposed and usually painful adiposity, confined to the face, neck and trunk, the extremities being spared; a tendency to become round shouldered, even to the point of measurable loss of height, associated with lumbo-spinal pains; sexual dystrophy shown by early amenorrhea in the females and ultimate impotence in the males; an alteration of the normal hirsuties shown by a tendency to hypertrichosis of face and trunk in all females and possibly the reverse in adult males; a dusky plethoric appearance of the skin with purplish lineae atrophicae; vascular hypertension; a tendency to erythremia; variable backaches, abdominal pains, fatigability and ultimate extreme weakness." Basophilism is usually seen in the brunette



FIG. 4. Case II. Eosinophil adenoma producing acromegaly.



FIG. 5. Case III. Case of basophil adenoma (Cushing's syndrome) which came to autopsy.

just as eosinophilism. The roentgenogram as a rule does not show any distortion of the sella turcica because the adenomas are so small.

We see, therefore, that all three types, the chromophobe, the eosinophil and the basophil adenomas, lead to amenorrhea. In the chromophobe variety with resulting hypofunction, there is a lack of stimulus to the ovarian follicle with resulting amenorrhea.

SUMMARY

Three cases are shown representing the three types of pituitary adenomas, viz., chromophobe, eosinophil and basophil.

The chromophobe variety leads to hypofunction of the pituitary and may be compared to the colloid goiter with myxedema.

The eosinophil adenoma produces acromegaly and represents hyperpituitarism.

The basophil adenoma produces the syndrome known as basophilism or Cushing's syndrome. It also represents a type of hyperpituitarism.

All three types produce amenorrhea. The three types may be diagnosed from their respective clinical pictures.

necessary to anesthetize the throat, but we find it more satisfactory as a rule to do so. The pharynx and anterior faucial pillars are sprayed lightly with a 4 per cent aque-

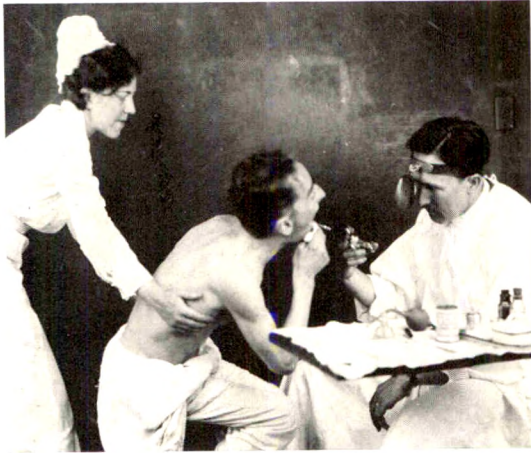


FIG. 13. Position of the patient for lipiodol filling of the right middle lobe.

ous solution of cocaine hydrochloride, and, if the upper third of a lung is to be injected, the larynx also is so anesthetized.

Temperature of the Lipiodol. Heating the lipiodol above body temperature lowers its viscosity and makes the injection easier for the operator, but there are objections to this. A very freely flowing oil enters the pulmonary alveoli more readily, thus tending to obscure the roentgenographic distinctness of the bronchi. Furthermore, oil in the alveoli is not easily expelled and may remain trapped there indefinitely, a disadvantage discussed above. It is better, therefore, not to heat lipiodol, as is often done, but to use it at a temperature of 65 to 75° F.

Section to be Injected; Amount of Oil. As a rule, it is advisable to inject only one lobe or section of one lung at a sitting, since this helps to avoid accidents. Further, if bronchi of both sides are injected simultaneously, it may be difficult or impossible to obtain readable lateral and oblique roentgenograms. For a lower lobe 10 to 20 c.c. of lipiodol suffices, and for the upper third of a lung, 10 to 15 c.c. If stenosis of the trachea or bronchus is suspected only about 5 c.c. are directed to the point in question by

carefully posturing the patient. It is always good practice to use the smallest quantity of oil adequate for the desired result. Sometimes a mere coating of the air tubes is enough.

Injection by Oral or Supraglottic Route.
Lower Parts of the Lung. The patient sits on a chair, leaning one way or another according to the lobe to be injected. For the right lower lobe he leans backward and to the right; for the right middle, forward and to the right (Fig. 13), and so on. Holding the patient's tongue the operator slowly injects the oil with a syringe attached to a curved laryngeal cannula, the tip of which is held above or just behind the epiglottis. Meanwhile the patient is instructed to breathe naturally.

Upper Parts of the Lung. The patient lies on a table on his affected side. The shoulder is lowered so that the apex of the lung is dependent, and, with the lowermost forearm flexed, the patient props his head in his hand. With his free hand he grasps his tongue in a piece of gauze and holds it out. With the patient's neck bent toward the unaffected side, the operator, with the aid of a laryngeal mirror, places the tip of the

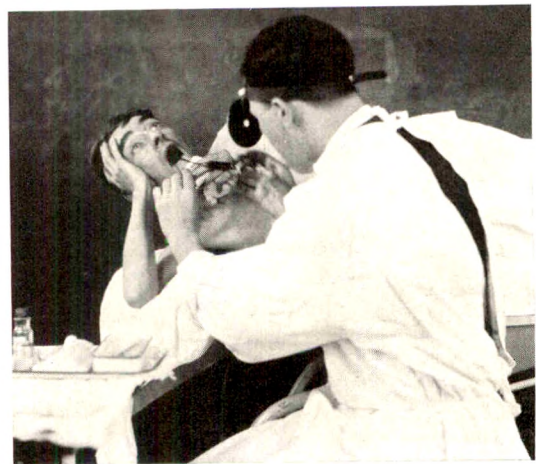


FIG. 14. Position of the patient for lipiodol filling of the right upper lobe.

cannula in the larynx and injects the oil quite slowly (Fig. 14). The patient continues to lie with his shoulders dependent, so that the oil does not flow into the lower

"MILIARY" PULMONARY HEMORRHAGES ON NECROPSY ROENTGENOGRAMS OF CHILDREN*

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WHERE post-mortem roentgenograms are used as an adjunct to necropsy or as a substitute for diagnostic purposes, when autopsy permission cannot be obtained, certain unusual appearances have been noted that have apparently not been recognized and seem worthy of reporting. I refer to the extensive capillary hemorrhages in the lungs which cast shadows on the roent-

four days before death. Several stools had contained blood and pus. On admission to the hospital the day preceding death, she was delirious, dehydrated, pale, and acutely ill, and had convulsions. Respirations were rapid. The temperature was 103.4° F. The white count was 15,200 with 58 per cent polymorphonuclears and 42 per cent lymphocytes. The red count was 3,900,000; hemoglobin 60 per cent. The chest examination was reported negative.

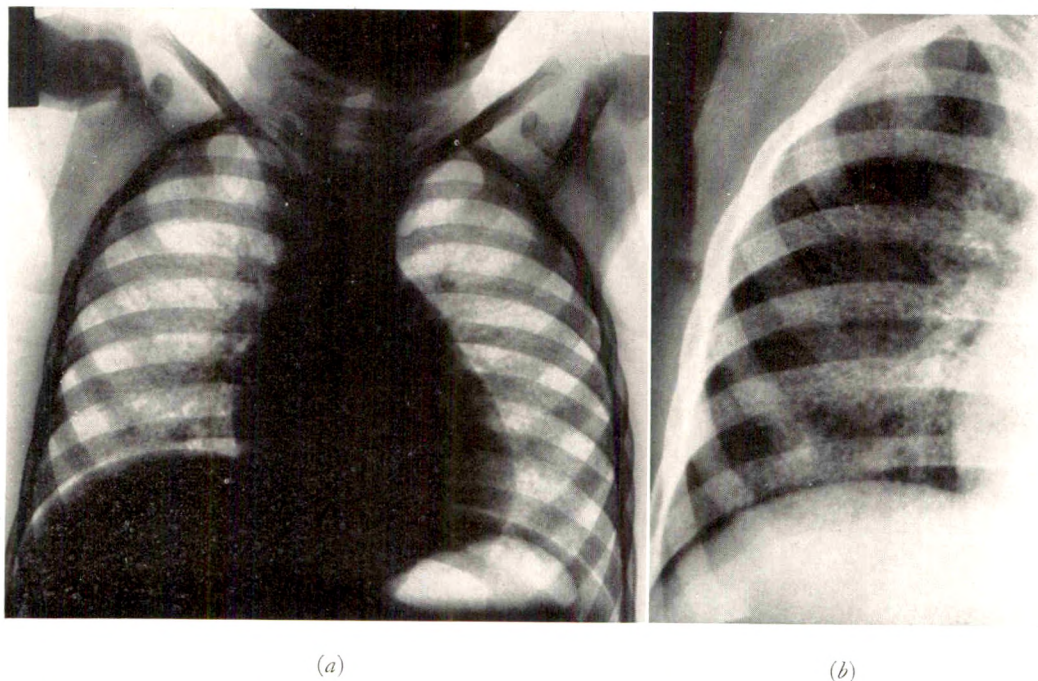


FIG. 1. Case I. (a) Even distribution of fine shadows (isolated hemorrhages) throughout lung fields simulating roentgen appearance of early miliary tuberculosis. (b) Positive reproduction. Note fine mottled appearance caused by the hemorrhages.

genogram so similar to that of other better known conditions that a mistaken interpretation would most likely occur. The films were made soon after death and just preceding necropsy.

CASE I. White female, aged two and a half. The history of this child was that of perfect health until she developed a diarrhea and fever

The temperature rose steadily, reaching a terminal level of 107.5° F. The clinical diagnosis was acute bacillary dysentery.

The roentgenogram (Fig. 1) of the chest taken shortly after death showed fine soft densities scattered throughout both lung fields, which were interpreted as having the typical roentgen appearance of miliary tuberculosis.

Necropsy. The post-mortem examination,

* This work has been made possible through post-mortem chest roentgen examinations established as a routine procedure by Dr. Joseph Brennemann at The Children's Memorial Hospital, Chicago.

bronchi; he rolls to the desired position and the roentgenograms are made. Afterwards it may be useful to have a roentgenogram with the patient in the erect position also.

Roentgenoscopy and Roentgenography. It is usually advisable to roentgenoscope immediately to ascertain roughly the extent of the filling. Roentgenograms are then made, employing a very long exposure or deep penetration in order to yield maximum visualization of the contrast material. Since a long time exposure may lead to blurring from motion, the roentgen tube may be moved close (24 inches target-film distance), thus shortening the time and increasing the penetration. Lateral views are also made to localize the injected parts more accurately; sometimes oblique views too. Stereograms may be made but we find posteroanterior, lateral and oblique views more serviceable. The use of a Potter-Bucky diaphragm, of course, makes for distinction and sharp contrast.

Emptying the Bronchi of Lipiodol. During

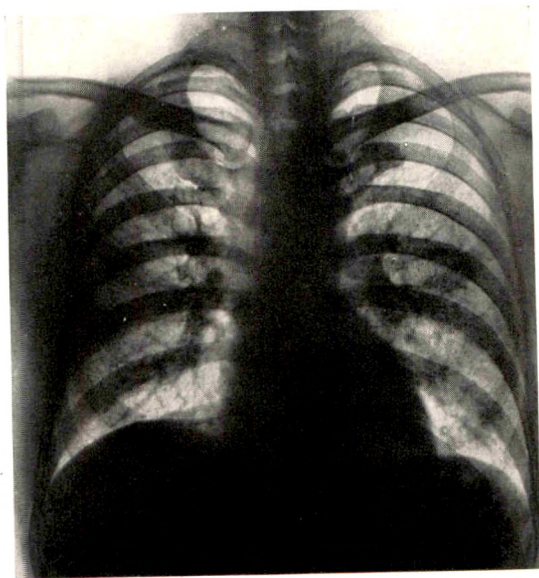


FIG. 15. Case S.D., admitted for chronic cough and expectoration; previous history of pneumonia; moderately coarse râles in right upper lobe; no evidence of tuberculosis.

the foregoing maneuvers it is important for the patient to restrain coughing or other

violent respiratory effort. After the roentgenograms are made the patient hangs over a table to drain his bronchi, without coughing. Most of the oil will flow out in ten or

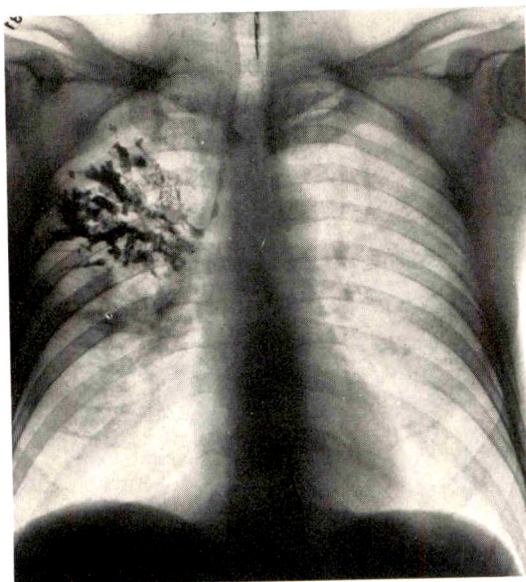


FIG. 16. Case S.D. Lipiodol bronchogram showing bronchiectasis in the right upper lobe. Bronchogram of lower lobes of both lungs showed no abnormalities (see Fig. 14).

fifteen minutes. For reasons discussed the importance of this postural drainage cannot be stressed too much.

Transtacheal Route. In young children and occasionally in older persons the oral route of oil instillation is impractical or intolerable, and the lipiodol may be injected by means of an 18-gauge needle inserted in the midline of the neck between two of the upper tracheal cartilages according to a method suggested by Heuser.¹⁸ The patient is prepared as described above and is placed on his back on a table, a rolled pillow beneath his neck and his head extended over this. Care should be taken to prevent the escape of lipiodol into the cervical tissues. This is facilitated by entering the trachea with a needle and syringe containing novocaine anesthetizing solution; then, with the needle in place, changing the syringe for one containing the oil. This method is not favored except as a necessary

which was limited to the trunk, showed no hemorrhages in the intestinal tract. The changes were those of a hyperemia and edema of the mucosa. Peyer's patches were prominent



FIG. 2. Case I. Photomicrograph $\times 25$. Numerous small hemorrhages surrounded by normal lung tissue, accounting for fine densities on necropsy films.

and congested. The mesenteric lymph nodes were numerous and large.

In the thoracic cavity there were no adhesions of either the pleural or pericardial sacs and there was no free fluid. Both lungs seemed a little distended. Externally their color was pink, the pleurae showing no hemorrhages. On section there were minute petechial hemorrhages sprinkled everywhere throughout the parenchyma. The intervening tissue was air-containing and crepitant. The bronchi and trachea had a congested lining and contained dark red blood-stained mucus. The tracheobronchial lymph nodes were not enlarged.

Although a special search was made, no hemorrhages could be found in other viscera.

Histology. Sections of the colon showed in-

filtration of the mucosa with round cells and necrosis of its superficial portion.

Sections of the ileum showed the mucosa to be necrobiotic or largely absent, with only a trace of the crypts remaining and these were dilated and irregular. The underlying Peyer's patches showed marked proliferation of the germinal centers, and edema and hyperemia of the follicles.

Sections of the lungs (Fig. 2) showed small hemorrhages scattered throughout the parenchyma, with normal lung tissue between the hemorrhagic areas. No evidence of consolidation could be found and there was no evidence of the inflammatory reaction about the individual hemorrhagic areas.

Bacteriology. Stool culture:—*B. dysenteriae*, Flexner. Pus from bronchus:—*Staphylococcus aureus* and large gram-positive bacilli. Lung parenchyma:—*Staphylococcus aureus* and *B. coli*.

Pathologic Diagnosis. Acute bacillary dysentery (Flexner); hyperemia and edema of the mucous lining of the ileum and colon; enlargement of mesenteric lymph nodes; fatty changes in the liver; hemorrhagic foci in the pulmonary parenchyma; hemorrhagic tracheobronchitis.

CASE II. White female, aged twenty-five days.

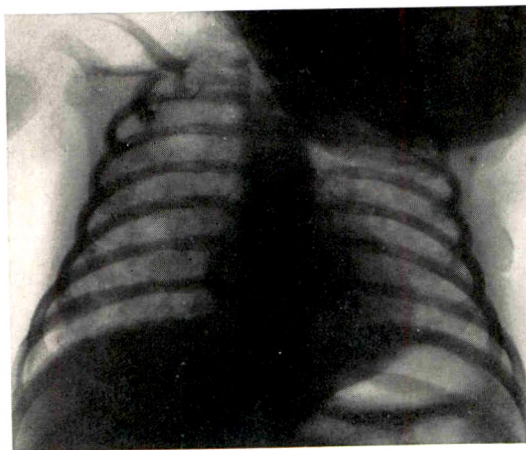


FIG. 3. Case II. Necropsy roentgenogram. Large irregular shadows produced by hemorrhages coalescing to produce whorl-like patterns. Note similarity to certain cases of bronchopneumonia (Fig. 5).

This infant was admitted to the hospital six days before death with the history of a bloody diarrhea of ten days' duration. Vomit-

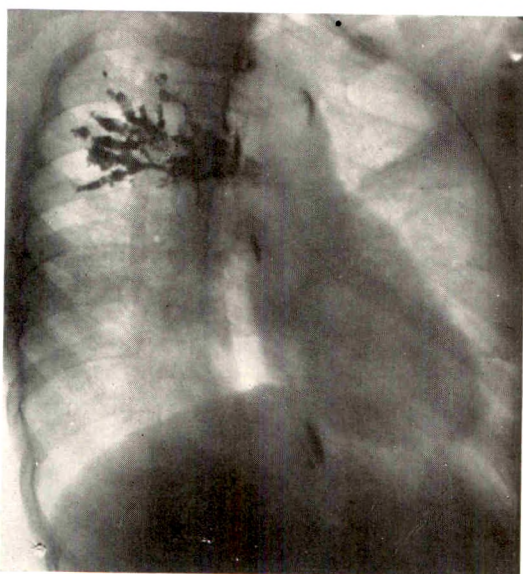


FIG. 17. Case S.D. Bronchogram with the patient in the oblique position to show the ramifications of the bronchiectasis.

substitute and we have used it only in young children. In the cases of two children we have used general nitrous oxide-oxygen anesthesia. The strain was less for the patients and the operation easier. Very satisfactory bronchograms were obtained while the patients were still anesthetized. There is much to recommend this method when good bronchograms are needed and the quiet cooperation of the patient cannot be expected.

Bronchoscopic Route. This is recommended by some because one can inject the lipiodol into a chosen single bronchus. However, we have not found it satisfactory because the lipiodol usually flows to other parts as the bronchoscope is withdrawn or is blasted about the bronchial tree by the heaving and coughing that almost inevitably attends and follows bronchoscopy. Furthermore, when lipiodol is injected into a single bronchus through a long cannula it seems easy to produce a roentgenographic artefact. The oil may accumulate in a pool, which is easily mistaken in the roentgenogram for a bronchial sacculation, and remains indefinitely encysted, perhaps to the detriment of the patient. We have

seen a number of cases in which this occurred.

Injection of Fistulas, Sinuses and Abscess Spaces. This is a simple procedure and may be done with a needle or small catheter. It is well to wash out the tract before injecting the lipiodol, which is then allowed to flow in by gravity or under very low pressure; forceful injection may produce artefacts, trauma, or embolism (air or oil). Until the roentgenogram is made the lipiodol should be sealed, if necessary, in the tract by closing the external opening with adhesive plaster. Transparietal injection of pulmonary cavities is, in our experience, very seldom indicated.

SUMMARY

1. In order to secure the greatest diagnostic information from iodized oil bronchography and, at the same time, avoid the attendant hazards, an understanding of the behavior of oil in the lungs is fundamental. This is explained.

2. In most cases retained lipiodol is gradually discharged through the bronchi. Direct absorption through the lung occurs only to a slight degree, if at all.

3. A slight exudative reaction usually occurs about deposits of lipiodol in the healthy lung but this seems not to be harmful in the clinical sense. The transudation of edema fluid may be considerable and this may account for the rapidly developing roentgenographic lobar opacity reported by some authors.

4. Lipiodol may be retained for days, months or years in the pulmonary alveoli. From the roentgenological point of view, this "contrast medium infiltrate" is a diagnostic disadvantage. The persisting densities may impair the value of serial roentgenograms as guides for treatment.

5. Disadvantages and dangers peculiar to the cricothyroid or transtracheal method of injection include the escape of oil into and indefinite retention in the cervical and mediastinal tissues; the more or less serious infection of these tissues by escaping bronchial discharges; and, less often, pain, dys-

ing had been present at the onset. The previous history was that of a normal birth. Delivery had been at full-term; birth weight was $7\frac{1}{2}$ pounds. There had been no convulsions, cyanosis, or hemorrhages noted. A cow's milk formula had been used since birth. A few days before death there was a bilateral otitis media which had yielded pus, but both ears had healed before death occurred. At no time had there been symptoms of pulmonary involvement. The temperature had never been elevated more than 2 degrees.

The roentgenogram (Fig. 3) of the chest taken after death showed unusual irregular soft tissue densities scattered throughout the lung fields, confluent in places. The heart shadow did not appear enlarged or abnormal in shape. The shadow of the upper mediastinal structures was not considered abnormal.

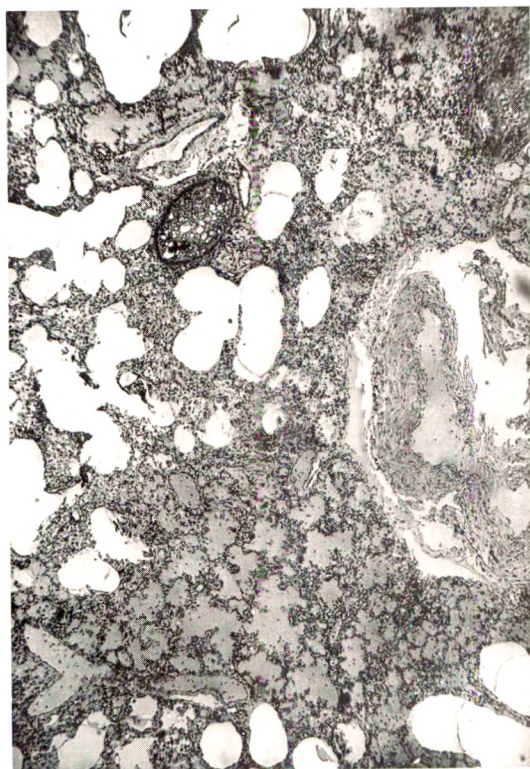


FIG. 4. Case II. Photomicrograph $\times 65$. Individual hemorrhages filling several alveoli and accounting for striking shadows on necropsy film.

Necropsy. The gastrointestinal tract showed many tiny fresh-looking ulcers, varying from 0.5 to 2 mm. in diameter, in the region of the Peyer's patches. The intervening mucosa was

normal. The mesenteric and ileocecal lymph nodes were enlarged.

On opening the thoracic cavity no exudate or adhesions were found. The lungs were

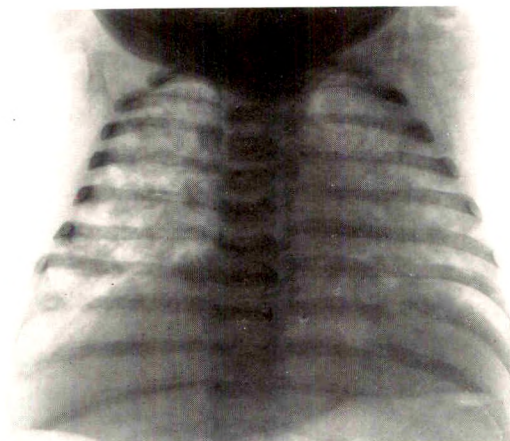


FIG. 5. Necropsy film. Case of focal hemorrhagic pneumonia secondary to extensive furunculosis (*Staphylococcus aureus*). Note marked similarity of roentgen densities to Case II (Fig. 3).

mottled with dark red spots against a normal pink background. On section, the same pattern was found to extend throughout both lungs. The lesions seemed to consist of localized hemorrhages, apparently of recent origin, as they did not feel indurated and the lobules were not shrunk. Little blood oozed from the cut surface. There was mild congestion of the mucosal lining of the bronchi and trachea. The mediastinal nodes were not enlarged.

The only other abnormal changes found were those of a mild hyperemia of all the viscera. The lines of ossification of the ribs were straight and regular, revealing no evidence of rickets or scurvy. The brain was not examined.

Histology. Sections of the lung (Fig. 4) showed innumerable alveoli containing blood as well as hemorrhages into the lung tissue, with blood still liquid in places. There was no evidence of round cell infiltration. The bronchi seemed normal.

Section of the ileum showed the mucosa and outer part of the submucosa absent in many places. The deeper part of the submucosa was necrobiotic and infiltrated with wandering cells. The muscularis was not affected.

Bacteriology. Cultures of pus from the lung and from the throat showed a heavy growth on blood agar plate, from which only bacilli of

phonia, edema of glottis, dysphagia, subcutaneous emphysema and air embolism.

6. Iodism is due mostly to the swallowing of the oil and absorption of iodine through the intestine. Usually it can be avoided by carefully injecting the oil in small amounts, adopting measures to prevent retention in the lungs, postural drainage of the bronchi after bronchography, and finally the administration of a brisk saline purge.

7. In cases of infectious pulmonary disease, mainly tuberculosis and acute or chronic suppurative conditions, dissemination or aggravation can be caused by lipiodol injection. The reasons for this are given. Serious results and several fatalities are placed on record.

8. Cases are also cited to prove the potential—even fatal—risk of intratracheal injection of iodized oil in cases with impaired cardiac or respiratory function from different causes.

9. Rational and effective ways to avoid the disadvantages and hazards are described. By adopting these measures the many advantages of lipiodol bronchography can be achieved usually without harm to the patient.

10. Principles governing the selection of cases are stated. The technique of safe, adequate and simple methods of performing the procedure are described.

We wish to express our appreciation to Dr. James Alexander Miller, in whose Service at Bellevue Hospital this experience was gained.

REFERENCES

1. AMAKO, T. H. Ueber die bakterizide Wirkung des Jodipins gegenüber Tuberkelbazillen und anderen Bakterien. *Ztschr. f. Tuberk.*, 1930, 58, 178-183.
2. ANDERSON, W. Some observations on the value of intratracheal injections of iodized oil for bronchial asthma. *J. Allergy*, 1932, 4, 44-47.
3. ARCHIBALD, E. W., and BROWN, A. L. Dangers of introducing iodized oil into the tracheobronchial system. *J. Am. M. Ass.*, 1927, 88, 1310-1315.
4. BETTMAN, R. B., KELLY, J., and CROHN, N. Effect of intrabronchial injections of iodized poppy seed oil; experimental study on dogs. *Arch. Surg.*, 1929, 19, 471-477.
5. BEZANÇON, F., WEIL, M. P., AZCOULAY, R., and BERNARD, E. Forme sèche hémoptoïque de la dilation des bronches. *Bull. Acad. de méd.*, 1924, 91, 100.
6. BLOCH, R. G. The viscosity of lipiodol in bronchography. *Am. J. Roentgenol. & Rad. Therapy*, 1932, 27, 847-852.
7. BONNAMOUR, S., BADOLLE, A., and GAILLARD, R. Le radiodiagnostic dans les affections bronchopulmonaires par le lipiodol. L'Expansion Scientifique Française, Paris, 1929.
8. BRAUER, L., and LOREY, A. Die röntgenologische Darstellung der Bronchien mittels Kontrastfüllung. *Ergebn. d. med. Strahlenforsch.*, 1928, 3, 117-174.
9. BROWN, A. L. The fate of iodized oil (lipiodol) in the lungs. *Surg., Gynec. & Obst.*, 1928, 46, 597-601.
10. BROWN, A. L., and ARCHIBALD, E. The action of cough upon material in the tracheobronchial tract. *Am. Rev. Tuberc.*, 1927, 16, 111-122.
11. CORPER, H. J., and FREED, H. The intratracheal injection of oils for diagnostic purposes. *J. Am. M. Ass.*, 1922, 79, 1739.
12. DUKEN, J., and VON DEN STEINEN, R. Das Krankheitsbild der Bronchiektasie im Kindesalter. *Ergebn. d. inn. Med. u. Kinderh.*, 1928, 34, 457-566.
13. FORESTIER and QUENTZ. Le lipiodol—indications générales, contre-indications, accidents. *J. de radiol. et d'électrol.*, 1929, 13, 665-670.
14. FRIED, B. M., and WHITAKER, L. R. Intratracheal injection of iodized oil. *Arch. Int. Med.*, 1927, 40, 726-739.
15. GREENBAUM, F. R. A new feature in iodized oils. *Radiology*, 1932, 18, 1115-1123.
16. GRILL, C. Observations on the dangers of lipiodol injection into the air passages. *Upsala Läkaref. Förh.*, 1927, 33, 355-366.
17. GUIEYSSE-PELLISSIER, A. Recherches sur l'absorption de l'huile dans le poumon. *Compt. rend. Soc. de biol.*, 1920, 83, 809.
18. HEUSER. Die Einspitzung von Jodöl in Bronchien, Gebärmutter und Eileiter. *Verhandl. d. deutsch. Röntgen-Gesellsch.*, 1925, 16, 56-57.
19. JACCHIA, P. Sind bei Bronchographien dick- oder dünnflüssige Kontrastmittel vorzuziehen? *Röntgenpraxis*, 1930, 2, 1045-1051.
20. JACOBUS, H. C. SELANDER, G., and WESTERMARK, N. Attempt at a clinical functional test of the emptying capacity of the bronchi. *Acta med. Scandinav.*, 1929, 71, 379-437.

the colon-aerogenes group, some producing hemolysis, could be isolated.

In cultures of intestinal contents, only bacilli of the colon-aerogenes group were found. Two restreakings yielded no different results.

In cultures of the heart's blood, bacilli of the colon-aerogenes group (non-hemolytic) were found.

Pathologic Diagnosis. Malnutrition; dehydration; multiple hemorrhages in the lung; focal ulcerations in Peyer's patches of the ileum; congestion of all viscera; septicemia, *B. coli*.

INTERPRETATION

Few pulmonary lesions show a more general distribution of uniform fine densities on the roentgenogram than does miliary tuberculosis in children. However, that similar shadows varying from mere specks to 2 mm. in diameter may be produced by



FIG. 6. Photomicrograph $\times 20$. Case illustrated in Figure 5. Areas of consolidation accounting for roentgen shadows. Note the proportion of "solid" areas to air-containing spaces, similar to that produced by hemorrhages in Case II (Fig. 4), accounting for the roentgen appearance.

fine hemorrhages in the lungs is illustrated by the 2 cases here reported. They resemble miliary tuberculosis in that they both can produce snowflake-like densities

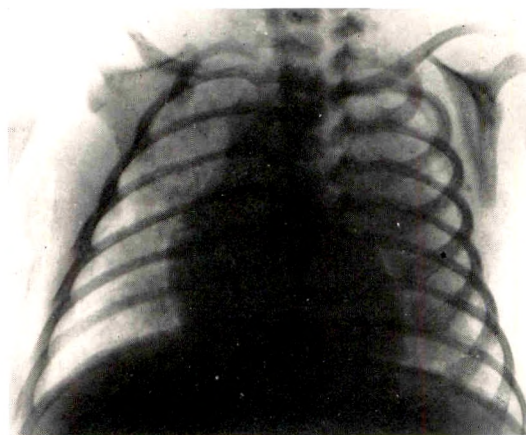


FIG. 7. Widespread interstitial pneumonia secondary to infection of navel (*Streptococcus hemolyticus*) in child a week old. Smooth, fine-grained clouding of both lung fields, only slightly unlike the more or less discrete shadows of generalized small hemorrhages (Fig. 3). Note lung fields are incompletely involved and separate shadows of hemorrhages are not present.

on the post-mortem roentgenogram. However, hemorrhages of this type have not been observed on roentgenograms made during life. A study suggests that they occur while death is taking place and consequently, for practical purposes, the fine shadows they produce need not be confused with other conditions causing a similar appearance on the films made during life.

When the individual hemorrhages are 1 to 2 mm. in diameter, presenting whorls or crescentic shadows of "miliary" distribution on the film, certain forms of bronchopneumonia and other rarer conditions are apt to be considered. For example, pneumonia produced by the *Staphylococcus aureus* resembles the larger type of scattered hemorrhages (Case II) when the small areas of consolidation (Figs. 5 and 6) tending to produce abscesses are extensively scattered throughout both lungs. Many cases of this kind in epidemic form were

21. JACOBUS, H. C., SELANDER, G., and WESTERMARK, N. A study of acute massive atelectatic collapse of the lung. *Acta med. Scandinav.*, 1929, 71, 439-466.
22. KNIPPING, H. W., and PONNDORF, W. Ueber die Füllung der Lungen mit Iodol. *Beitr. z. Klin. d. Tuberk.*, 1926, 63, 329-359.
23. KÖHLER, B. Eine missglückte Bronchographie. *Acta radiol.*, 1932, 13, 54-56.
24. LAUGHLEN, G. F. Pneumonia following nasopharyngeal injections of oil. *Am. J. Path.*, 1925, 1, 407-414.
25. LENK, R., and HASLINGER, F. Röntgenuntersuchungen an normalen und kranken Bronchien nach Füllung mit Lipiodol. *Klin. Wchenschr.*, 1925, 4, 1533-1535.
26. MACDONALD, I. G. The local and constitutional pathology of bronchial asthma. *Ann. Int. Med.*, 1932, 6, 253-277.
27. MORVAY, E. Fremdkörpergranulationen der Lunge nach diagnostischer Bronchographie. *Röntgenpraxis*, 1931, 3, 581-586.
28. OLMER, D., and ZUCCOLI, G. Accidents nerveux subits épileptiformes au cours d'une injection intratrachéale de lipiodol. *Paris méd.*, 1929, 2, 306-307.
29. PEIPER, H., and KLOSE, H. Ueber die Grundlagen einer Myelographie. *Arch. f. klin. Chir.*, 1925, 134, 303-387.
30. PIERSON, J. W. Some unusual pneumonias associated with the aspiration of fats and oils in the lung. *Am. J. Roentgenol. & Rad. Therapy*, 1932, 27, 572-579.
31. PINCHIN, A. J. S., and MORLOCK, H. V. Acute massive collapse of the lung following lipiodol injection. *Brit. M. J.*, 1931, 1, 930.
32. PINKERTON, H. Oils and fats; their entrance into and fate in the lungs of infants and children. *Am. J. Dis. Child.*, 1927, 33, 259-285.
33. PINKERTON, H. The reaction to oils and fats in the lung. *Arch. Path.*, 1928, 5, 380-401.
34. Report of the Council on Pharmacy and Chemistry. Dangers of the injection of iodized oils. *J. Am. M. Ass.*, 1932, 99, 1946.
35. ROGER, H. The action of the lung upon fatty substances. *French Med. Rev.*, 1931, 1, 1-10.
36. SICARD, J. A., and FORESTIER, J. The Use of Lipiodol in Diagnosis and Treatment. Oxford University Press, New York and London, 1932.
37. SINGER, S. Die Bronchographie. *Ergebn. d. inn. Med. u. Kinderh.*, 1929, 35, 429-464.
38. SWINDLE, P. F. Mechanical factors contributing to the exchange of fluids in the body; conditions favorable to ejection, filtration, injection, aspiration, and deflection of fluids through tubes and membranes. *Am. J. Physiol.*, 1930, 93, 588-599.
39. VAN ALLEN, C. M., LINDSKOG, G. E., and RICHTER, H. G. Collateral respiration. *J. Clin. Investigation*, 1931, 10, 559-590.
40. VAN ALLEN, C. M., and SOO, Y. C. Collateral respiration. *J. Clin. Investigation*, 1933, 12, 171-179.
41. WATERS, C. A., BAYNE-JONES, S., and ROWNTREE, L. G. Roentgenography of the lungs; roentgenographic studies in living animals after intratracheal injection of iodoform emulsion. *Arch. Int. Med.*, 1917, 19, 538.
42. WINTERNITZ, H. Ueber Jodöle und ihr Verhalten gegenüber Körpergeweben. *Deutsche med. Wchenschr.*, 1931, 57, 1704-1705.



observed following influenza in 1918. Widespread distribution of similarly fine, consolidated, or necrotic areas in the lungs are found sporadically as the result of

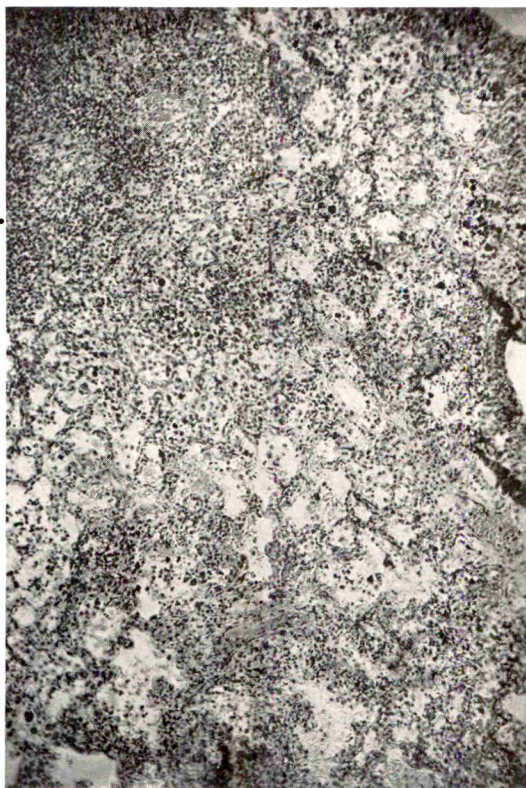


FIG. 8. Photomicrograph $\times 65$. Same patient as in Figure 7. Note smooth transition from partially air-containing areas to areas of greater consolidation, which explains the almost general clouding of both lung fields on necropsy film.

blood-borne infections. In children, death usually follows closely upon the development of the abscesses, and the widespread scattered densities throughout the lung fields are therefore seldom encountered on the film during life. The only cases of this kind which I have seen with this distribution were observed on the necropsy film. In one case the film taken twenty-four hours before death did not show generalized shadows, but they were present on the film after death.

In cases of influenza, bilateral and multilobar pneumonia has been seen which presented widespread fine discrete shadows

on the roentgenogram, but, as a rule, the areas were not uniform in density, in distribution, in size, or in form.

Interstitial forms of pneumonia seldom have the roentgen appearance of fine uniform densities scattered throughout both lung fields. When this is approximated (Figs. 7 and 8), a dust-like cloudiness may be produced on the roentgenogram.

In pulmonary edema, where there is saturation with serous fluid exuding from the capillaries, there may occur a general blotting out of air in the lung. Here the perfect water-like translucent smoothness of the shadow is more or less conclusive evidence of the true condition. Usually, when this involvement is not so extensive, the smooth shadow reaches out only a short distance from the hila and in this way simulates hypostasis or congestion, frequent findings on the necropsy film, but bears little resemblance to the widespread figured patterns of fine pulmonary hemorrhages.

In certain congenital disturbances in lipid metabolism (Niemann-Pick's disease, xanthomatosis, and Gaucher's disease), the alveolar spaces may contain large numbers of foam cells evenly scattered throughout the lungs producing a roentgen pattern simulating generalized fine foci of a blood-borne infection or hemorrhages. This condition in young children is frequently associated with an enlarged liver and spleen or bone defects, which should suggest the likelihood of local manifestations of a general disorder of this kind rather than "miliary" pulmonary hemorrhages.

In cases of eosinophilic leucemia, the leucemic infiltrations may appear as uniformly faint shadows of varying size scattered throughout the lungs, resembling closely the shadows of numerous fine hemorrhages as seen at necropsy.

CONCLUSION

Evenly spaced fine hemorrhages in the lungs of young children can produce a

TUBERCULOSIS OF THE KNEE JOINT

A COMPARISON OF ITS MORBID ANATOMY WITH ITS ROENTGENOLOGIC MANIFESTATIONS

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IT CAN be readily understood that correct interpretation of roentgenograms of diseased joints is by no means easy when it is considered how seldom they are checked by pathologic data. Simple exploration of a joint may lead to a fairly accurate conception of its contents, but many details of such explorations necessarily are not recorded. This lack of accurate corroboration of roentgenologic data has, in many instances, led to incorrect interpretation. Opportunity has been given us to study a series of specimens of resected knee joints and to compare the pathologic changes thus found with the clinical records and roentgenograms. The results of our observations are presented.

MATERIAL STUDIED

A series of 113 resected knees and seven amputated legs was studied. Ninety-five (84.1 per cent) of the resected knees were diagnosed as tuberculous by pathologic examination, 17 (15 per cent) were found to be inflammatory and one (0.9 per cent) presented the typical picture of a Charcot joint. All the amputated legs were tuberculous; an incidence of tuberculosis in the series of 85 per cent.

In the entire series there were 77 cases in which roentgenograms of the knee were available. Of these, 65 cases were tuberculous, 11 were nontuberculous arthritis, and one case was a Charcot joint. In each case a complete gross specimen of the knee joint had been preserved from which microscopic sections were cut in order to corroborate the original pathologic diagnosis.

PATHOLOGIC CHANGES

By the time a patient suffering from a tuberculous knee joint has sufficient trouble to consult a physician, or, more often, by the time trouble has become sufficiently established so that the physician can recognize or even suspect tuberculosis, the pathologic changes have usually become so far advanced as to involve both synovial membrane and bone. The older conception of primary disease of the bone or primary disease of the synovia was the basis for many futile arguments. It is our belief that, with few exceptions, we do not recognize the disease clinically until it has invaded both structures.

In any case the disease is a hematogenous infection secondary to tuberculosis elsewhere in the body, although the focus is not often apparent. Beginning with the miliary tubercle, usually in the epiphysis, the infection in the bone may become walled off and temporarily inactive; it may spread toward the joint, attacking and perforating the cartilage, or it may advance to the synovial membrane at its point of reflexion from the bone. The structure of the bone may be gradually replaced by tuberculous granulation tissue, whereas areas of bone may become necrotic, with formation of sequestrum due to interference with the blood supply, or areas of caseation may occur with the formation of abscesses of bone which may later perforate the joint. The synovial infection whether primary or secondary to a lesion of bone is characterized by the formation of a marginal tuberculous pannus which creeps over

roentgenologic appearance after death closely resembling the shadows of a relatively early miliary tuberculosis. These hemorrhages apparently occur as death takes place and have not been found on roentgenograms made during life. A mistaken interpretation could easily be made where the necropsy film is relied upon for diagnostic purposes. Minute hemorrhages in a child two and a half years of age and larger hemorrhages in an infant twenty-

five days old are reported. The roentgen pattern of the larger hemorrhages may simulate those of other pulmonary conditions, as well as miliary tuberculosis.

For the careful check of the post-mortem findings I am indebted to Drs. I. J. Wolman and W. G. Hibbs.

The case shown in Figure 5 was used by permission of Profs. P. C. Hodges and B. Hamilton of the University of Chicago Clinics, as it more closely resembled the roentgen pattern of Case 11 than any of my own cases.



the articular surface, eroding the cartilage as it goes. At the central pressure area this is usually rubbed off by the opposing articular surface, so that this portion of the cartilage tends to be preserved longer. At the same time there is marginal infiltration and destruction of the bone and the production of subchondral granulation tissue, which spreads toward the center of the joint, eroding the cartilage from below. This tissue may or may not have the characteristics of tuberculosis. In some cases it dips down at the pressure area to separate a sequestrum from the surrounding bone, and often it lowers the resistance of the central cartilage so that it is destroyed by pressure erosion from above. Therefore, although in some cases the greatest cartilaginous destruction is peripheral, in others it is at the area of greatest pressure. In practically all cases there is atrophy of bone due to tuberculous infiltration and disease. Cartilage is destroyed very slowly and may be preserved in the joint for years, although devitalized and separated from the bone. It is replaced slowly by fibrous tissue, so that ankylosis of bone does not occur in these cases unless secondary infection is present. As a basis for comparison we shall refer frequently to the 11 non-tuberculous specimens on which we have complete data, including the roentgenograms.

HISTORICAL DATA

König, in 1884, presented the first clear-cut description of the disease, as noted in a large series of pathologic specimens, and very few additions of note have been made to his work. In 1906, he mentioned the roentgen rays as a factor in diagnosis, pointing out the uniform atrophy of bone, the destruction of cartilage, the presence of abscesses in bone and sequestra, and the slow progress of the disease, as demonstrated by the roentgenogram. He noted, however, the inability to visualize the early wedge-shaped tuberculous areas in surrounding healthy bone, or the tuberculous granulation tissue whether in the

bone or in the joint, and intimated that tuberculosis might be present for some time before roentgenologic changes became apparent.

Since König's pioneer work, opinions have differed as to the diagnostic value of the roentgenogram. Fraser described the encysted, infiltrating, atrophic and hypertrophic pathologic varieties of the disease in bone and was able to identify each on the roentgenogram. He pointed out the smoky, bulging synovia, marginal surface and deep erosion of cartilage of the joints and finally destruction of bone. Ely stated that the roentgenogram should only be used as confirmatory evidence, and although a well-defined focus in bone can be distinguished, roentgenograms of synovial tuberculosis are often of little value. Woldenberg confessed his difficulty in distinguishing tuberculosis from other types of arthritis by means of roentgenograms. One of us (Ghormley) in a previous article pointed out the marked infrequency of roentgenologic changes in early cases of tuberculosis of joints. Most recent writers have concurred in this view, among whom are Sundt, Girdlestone, and Allison. Allison claims that syphilis or gonorrhea may produce identical capsular and cartilaginous changes, that formation of new bone is not infrequently seen in tuberculosis and that thinning of the cortex is seen in all bones that are not used. The last mentioned factor has been stressed by Phemister⁹ who stated that interruption or loss of cortical substance on the articular surface is the most definite roentgen sign in tuberculosis, occurring from four to twelve months after the onset of the disease. He also attached great significance to the preservation of cartilage and hence the width of the joint space at the areas of greatest pressure, notably the central areas, and the external surfaces rather than the internal. He noted the presence of marginal erosion, due to invasion of bone by tuberculosis beneath the cartilage at the point of synovial reflexion, but also observed articular lipping in some cases.

FURTHER CHOLECYSTOGRAPHIC STUDIES IN THE LATE MONTHS OF PREGNANCY*

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THE relationship of pregnancy to gallbladder disease was recognized in the Sixteenth Century by Ettmuller.⁸ He directed attention to the frequency of the occurrence of biliary colic during pregnancy and after childbirth.

Huchard,¹² whose article appeared in 1882, stressed the frequent incidence of gallstones in gravid women. Since then many articles have been published making available an abundance of statistical data on the subject to support this observation.

Surgical figures from various sources indicate that from 70 to 90 per cent of women operated on for gallstones have borne children.

It occurred to us that probable alterations in gallbladder function during the late months of pregnancy might be demonstrated by cholecystographic studies. In a previous communication¹³ in 1928, we presented the results of cholecystographic examinations in 17 young primiparas, in whom there was no evidence of biliary tract disease. We were impressed by the observation that, in this small group, the gallbladder failed to visualize in 7 instances. The purpose of this presentation is to report further cholecystographic studies in 22 additional cases, a total of 39. In this last group plasma cholesterol estimations were also determined. We were able to repeat the cholecystographic and cholesterol studies in 7 of these cases after delivery.

VISUALIZED GROUP

Our findings in humans differ from the work of Mann and Higgins¹⁴ who concluded from experiments in certain species of animals that emptying of the gallbladder is delayed or that it does not empty at all during pregnancy.

In our group the gallbladder was visual-

ized in 19 of the 39 cases. There was no delay in the time of appearance of the shadow. The Boyden⁴ meal was administered to all, and in each instance the gallbladder shadow was markedly diminished in size or complete emptying occurred in from one to two hours. No change in the size of the viscus was noted as compared with non-pregnant women.

In 17 cases the gallbladder was displaced upwards and to the right, and pressure defects were seen in several. Crossen and Moore⁶ likewise reported a similar modification in position, in their studies of pregnant women.

NON-VISUALIZED GROUP

The gallbladder failed to visualize in 20 of the 39 cases studied. It was apparent from the position of the fetus that the uterus approximated the region of the liver and gallbladder. We do not believe that mechanical pressure is responsible for shadow failure owing to the fact that in the 19 visualized cases the uterus occupied a similar position in its relationship to the liver and gallbladder.

At the present time we are unable to offer any explanation to account for the failure of the gallbladder to visualize in a group of normal young primiparas considering that in an almost equal number shadows were obtained under similar conditions.

We therefore doubt until further, more definite proof is available that pressure on the gallbladder and ducts, caused by the greatly enlarged uterus, is responsible for shadow failure.

It is not reasonable to believe that the technical difficulty caused by projection of the rays through the increased volume of the abdominal contents during the late

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

Briefly, the usual roentgenographic characteristics of tuberculous arthritis as described by various writers are: (1) atrophy of bone; (2) general haziness of the joint; (3) erosion of margin of bone; (4) thinning or interruption of the articular cortex; (5) abscesses of bone or sequestra in some cases, and (6) late preservation of the cartilage of the joint and normal width of the joint space. The latter is explained by Phemister¹⁰ by the absence of proteolytic ferments in the tuberculous exudate, permitting the presence of the cartilage even though dead and separated from the bone, the process of digestion, absorption and narrowing of the joint space being thereby prolonged.

On the other hand, the following signs are thought to occur in cases of the non-articular form of nontuberculous infectious arthritis or in septic joints: (1) early and complete destruction of cartilage with narrowing of the joint space; (2) involvement of more than the margins of the areas of pressure; (3) the absence of abscesses of bone or sequestra; (4) a tendency to generalized or spotted hypertrophy; (5) articular lipping, and (6) ankylosis in the late stages of both the tuberculous and the nontuberculous varieties, together with advanced destruction of the articular surfaces of bone. In any case in which there has been disuse of the part for any length of time the ordinary changes will be modified by the usual atrophy of disuse.

ROENTGENOLOGIC DATA

In most of our tuberculous cases, well-marked atrophy of bone was discovered on roentgenologic examination. The exceptions were, however, numerous. In the 65 cases of tuberculosis, atrophy of bone was present in 50 (76.9 per cent); increased density of bone or hypertrophic changes in 8 (12.3 per cent), and there was no appreciable change from the normal in 7 (10.8 per cent). In 3 cases the hypertrophic changes were so pronounced as to suggest a pre-operative roentgenologic diagnosis of Charcot joint. In the series of nontuberculous

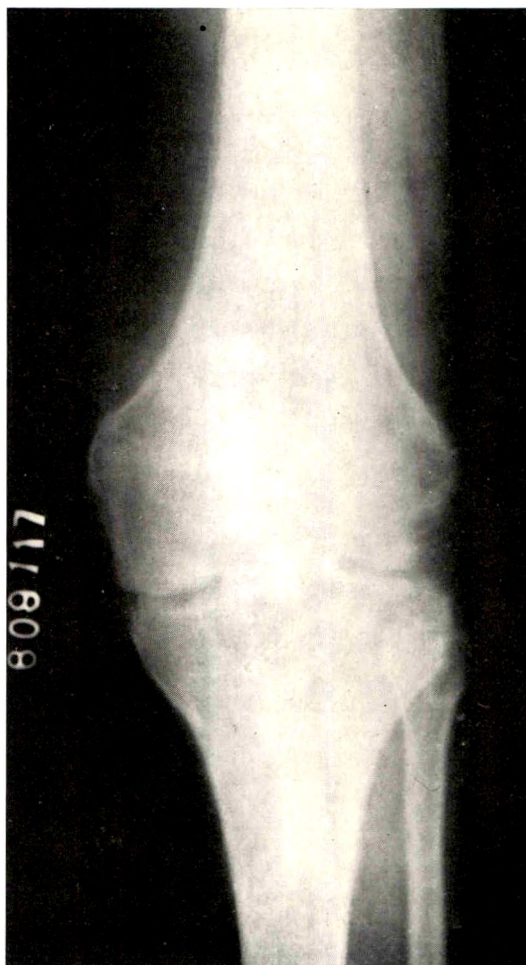


FIG. 1. Tuberculous knee joint of two years' duration; destruction of external condyle and erosion of the margin of bone of both tuberosities may be noted.

cases atrophy of bone was noted in 7 (63.6 per cent); hypertrophic changes were noted in 2 (18.2 per cent), and the changes were negligible in 2 cases. It would seem, then, that atrophy could not always be used in these cases as a differential diagnostic point.

DESTRUCTION OF CARTILAGE

Since cartilage is practically completely permeable to the roentgen ray, the only standard by which to judge its destruction or preservation is the amount of narrowing seen in the joint space. This interpretation must be made with care, because other fac-

months of pregnancy is responsible for non-visualization because in many cases in which visualization did occur, shadows with excellent definition were obtained even in obese patients.

GROUP STUDIED POST PARTUM

We were able to repeat the tests in 7 cases at various periods following delivery. In 3 whose gallbladders were not visualized before delivery shadows were obtained after. In 2 the shadows were normal as to density, and in the third the density was much fainter.

In 3 cases excellent visualization occurred before delivery, whereas after birth of the babies the density was greatly diminished in 2 instances, and no shadow resulted in the third. One failed to visualize both before and after delivery.

We are reluctant to draw any conclusion from this small group, but one is impressed by the fact that alterations of gallbladder function occur during pregnancy and following delivery.

PLASMA CHOLESTEROL DETERMINATIONS

This part of the investigation was conducted to determine whether or not there was any relationship between the plasma cholesterol findings and any alteration in gallbladder function as shown by cholecystography.

Hypercholesterolemia, in the later months of pregnancy, was shown by Herrmann and Neumann¹¹ in 1912. Their figures showed that the cholesterol in the plasma was 68.6 per cent over normal at term.

Chauffard, Laroche and Grigaut⁵ demonstrated that during the first six or seven months of pregnancy the serum cholesterol may be increased, and that in the last two months an increase of serum cholesterol is the rule.

Oser and Karr¹⁶ stated that the blood cholesterol is increased during pregnancy.

Slemons and Stander¹⁹ concluded that during the latter months of pregnancy the fats and the lipoids in the blood gradually increase, and that at full term the con-

centration is at least one-third greater than the accepted normal for women.

They considered normal those readings between 200 and 250 mg. per 100 c.c., and in their series of pregnant women the results varied from 190 to 330 mg., total cholesterol. They think that the increased lipoids have something to do with the storage for lactation.

Denis,⁷ in a group of early pregnancies, found normal figures.

Tyler and Underhill²⁰ concluded that, cholesterol, cholesterol esters, and lecithin increase gradually until term, when each is roughly one-third higher than at three months. They stressed the fact that in other conditions where cell multiplication goes on rapidly, there is a hypercholesterolemia.

Ferguson and Priestley⁹ followed 11 cases of their series for one and one-half years after delivery. They reported that in several of these cases hypercholesterolemia persisted.

The association of pregnancy and gallstone formation is well recognized, and many theories have been advanced to explain this phenomenon. It was shown by Aschoff and Bacmeister¹ that the majority of gallstones are constituted largely of cholesterol, and they suggested a derangement of the body lipoid metabolism as one of the main factors in the etiology of their formation. An increase in the biliary cholesterol combined with stasis and concentration of the bile in the gallbladder are factors which, according to them, are sufficient to cause crystallization and precipitation of cholesterol.

Chauffard, Laroche and Grigaut⁵ stated that gallstones are partly produced because of the large amount of cholesterol in the blood and bile during pregnancy. They also found that hypercholesterolemia persisted after pregnancy and was, therefore, useful in the diagnosis of gallstones. This work was confirmed by others, including Bell,² Wilensky and Rothschild,²¹ and Rothschild and Rosenthal.¹⁸

Myers¹⁵ could not confirm these results,



FIG. 2. The thick adherent pannus covers the external condyle of the gross specimen. The exposed cartilage shows only moderate destruction. Specimen from same case as that shown in Figure 1.

tors may cause modification of the roentgenographic appearance of the intra-articular area. The most important of these factors is the position of the knee at the time the roentgenogram is made. The greater the flexion at the knee, the narrower will be the representation of the joint space on the film, regardless of the amount of cartilage remaining. Ligamentous relaxation, displacement of the semilunar cartilage or subluxation of the joint will necessarily modify the width of the joint space in the roentgenogram. Stereorontgenography is helpful in determining the actual width.

In 49 (75.4 per cent) of the tuberculous cases varying degrees of cartilaginous destruction were present; localized destruction over the external surfaces was present in 7 (10.8 per cent), involvement only of the patellar cartilage in 3 (4.6 per cent), no definite change was noted in 4 (6.2 per cent) and flexion of the knee prevented

comparable interpretation in 2 (3 per cent).

Comparing these observations with the actual condition existing in the gross specimens, the roentgenologic interpretation proved to be correct as to the amount of cartilaginous destruction in 55 cases (84.6 per cent). In 2 cases (3 per cent) the roentgenograms suggested more destruction than was actually apparent, and in 6 cases (9 per cent) we had underestimated the amount of cartilaginous disease.

In the 11 nontuberculous cases the amount of destruction of cartilage seen in the roentgenograms checked with the gross changes in 6 cases (54.5 per cent) and less degeneration was shown in 5 (45.5 per cent) than actually existed.

On comparing the roentgenograms of the tuberculous and nontuberculous cases, we found that as a rule in the latter group



FIG. 3. The soft tissues of the same specimen as Figure 1 have been removed by caustic, demonstrating the actual destruction of bone.

and found normal blood cholesterol readings in most of the cases he examined.

Peters and Van Slyke¹⁷ stated that most recent studies have failed to establish any relation between gallstones and hypercholesterolemia.

METHOD

Five cubic centimeters of blood was taken for the cholesterol determination three hours after the ingestion of a low fat meal. The method of Bloor³ was used. There is a divergence of opinion as to the normal of the cholesterol values of the blood. Many writers place the normal between 100 and 160 mg. Gardner and Gainsborough¹⁰ stated that the reports of hypercholesterolemia must be reviewed critically. They contend that a precise figure is dangerous because the plasma cholesterol content varies within wide limits in normal individuals. They advocate the estimations of the free cholesterol and the cholesterol esters in every case. Peters and Van Slyke have adopted the figures of 100 to 230 mg. per 100 c.c. of total plasma cholesterol as representing the normal range.

We have accepted these figures as a basis for comparison.

Our group of 22 cases, in which cholesterol estimations were made, averaged 214 mg. per 100 cc. of blood.

TABLE I
CHOLESTEROL READINGS AND VISUALIZED GROUP

A HYPERCHOLESTEROL GROUP		B NORMAL CHOLESTEROL GROUP	
Case No.	Cholesterol Value	Case No.	Cholesterol Value
5	247	1	102
7	255	6	200
8	264	12	108
15	378	21	173
		22	143

In the visualized group our figures show the cholesterol values above the accepted high normals in 4 cases. Five were within the normal range.

In this series there is no relation between the cholesterol values and the ability of the gallbladder to concentrate the dye.

TABLE II
CHOLESTEROL READINGS AND NON-VISUALIZED GROUP

A HYPERCHOLESTEROL GROUP		B NORMAL CHOLESTEROL GROUP	
Case No.	Cholesterol Value	Case No.	Cholesterol Value
10	260	2	138
		3	222
24	286	4	140
		11	185
		13	222
		14	228
		16	224
		17	161
		18	225
		19	177
		20	228
		23	230

In 2 cases (10 and 24) increased cholesterol values were found. In 12 cases the readings were normal. It is therefore evident that no relationship exists between the plasma cholesterol values and failure of the gallbladder to concentrate the dye.

CHOLESTEROL READINGS, CHOLECYSTOGRAPHY, BEFORE AND AFTER DELIVERY

Case 1 had a four plus visualization in the ninth month of pregnancy with a plasma cholesterol of 102 mg., whereas, two and one-half months after delivery, two plus visualization with a plasma cholesterol of 238 mg. resulted.

Case 5 had a four plus visualization in the seventh month of pregnancy with a plasma cholesterol of 247 mg., and five weeks after delivery a plasma cholesterol of 225 mg., with a two plus visualization.

Case 7 had a four plus visualization in the eighth month of pregnancy with a plasma cholesterol of 255 mg. Six weeks after delivery no shadow resulted and the plasma cholesterol was 268 mg.

Case 3 did not visualize before delivery with a plasma cholesterol of 222 mg. Likewise there was no shadow after delivery and the plasma cholesterol was 248 mg.

Case 4 failed to visualize before delivery. The plasma cholesterol was 140 mg., whereas after delivery a one plus visualization resulted with a plasma cholesterol of 198 mg.

Case 10 did not visualize in the eighth month of pregnancy. The plasma cholesterol reading was 260 mg. Four plus visualization occurred six weeks after delivery, and the plasma cholesterol was 256 mg.

Case 17 did not visualize before delivery and the plasma cholesterol was 161 mg. After delivery a four plus visualization occurred with the plasma cholesterol 214 mg.

TABLE III
CHOLESTEROL READINGS, CHOLECYSTOGRAPHY,
BEFORE AND AFTER DELIVERY

Case No.	Visualization Before Delivery	Cholesterol Before Delivery	Visualization After Delivery	Cholesterol After Delivery
1	4	102	2	238
5	4	247	2	225
7	4	255	Non-Vis. o	268
3	Non-Vis. o	222	Non-Vis. o	248
4	Non-Vis. o	140	1	198
10	Non-Vis. o	260	4	256
17	Non-Vis. o	161	4	214

o, 1, 2, 3, 4 indicate degree of density of visualization.

It is obvious from this group, in which cholesterol determinations and cholecystographic studies were conducted before and after delivery, that it is impossible to form any conclusions because there was no constancy in the findings. Nevertheless, one is impressed by the failure of visualization

and alterations in the degree of density of the gallbladder shadows in young primiparas, in the late months of pregnancy and within six weeks after delivery.

CONCLUSIONS

1. The gallbladder failed to visualize in 20 instances in a group of young primiparas who had no history or clinical evidence of biliary tract disease.

2. Visualization resulted in 19 cases and the gallbladder occupied a high position in the abdominal cavity in all, and in many instances pressure defects were demonstrable.

3. The consistently high position and displacement of the gallbladder to the right due to pressure of the enlarged uterus and increased intra-abdominal tension did not delay the appearance time of the shadow nor interfere with response to the fat meal.

4. There was no appreciable difference in the plasma cholesterol values between the visualized and non-visualized groups.

5. There was no parallelism between the cholesterols and cholecystograms compared before and after delivery.

6. In 39 primiparas the intravenous injection of sodium tetraiodophenolphthalein produced no reactions other than a transitory sensation of warmth in 8 cases. There were no harmful effects on the mother, fetus, or the course of the pregnancy.

We desire to express our gratitude to Professor Francis C. Goldsborough, of the School of Medicine of the University of Buffalo, and to the personnel of the Ingleside Home for their hearty cooperation.

REFERENCES

1. ASCHOFF, L., and BACMEISTER, A. Die Cholelithiasis. G. Fischer, Jena, 1909.
2. BELL, J. R. Cholesterol metabolism in relation to pathogenesis and treatment of gallstones. *Brit. M. J.*, 1924, 1, 35.
3. BLOOR, W. R. The determination of cholesterol in blood. *J. Biol. Chem.*, 1917, 29, 437-445.
4. BOYDEN, E. A. The gall bladder in the cat. *Anat. Rec.*, 1922-1923, 24, 388-389.
5. CHAUFFARD, A., LAROCHE, G., and GRIGAUT, A. Evolution de la cholestérinémie au cours de l'état gravidique et puerpéral. *Compt. rend. Soc. de biol.*, 1911, 70, 536-537. Also: Le taux de la cholestérine dans le sang du cordon ombilical et dans le liquide amniotique. *Ibid.*, 568-569.
6. CROSSEN, R. J., and MOORE, SHERWOOD. Cholecystographic studies in pregnancy. *Am. J. Obst. & Gynec.*, 1928, 16, 840-844.
7. DENIS, W. Cholesterol in human blood under pathological conditions. *J. Biol. Chem.*, 1917, 29, 93-110.
8. ETTMULLER. De Ictero flavo, nigro et albo. Quoted by Graham et al. in: Diseases of the Gall Bladder and Bile Ducts. Lea and Febiger, Philadelphia, 1928, p. 143.

9. FERGUSON, L. K., and PRIESTLEY, J. T. The relation of gallbladder disease to pregnancy, with special reference to the factor of hypercholesterolemia. *Am. J. Obst. & Gynec.*, 1928, 16, 82-89.
10. GARDNER, J. A., and GAINSBOROUGH, H. Studies on the cholesterol content of normal human plasma. *Biochem. J.*, 1927, 21, 130-140.
11. HERRMANN, E., and NEUMANN, J. Ueber die Lipoidie der Gravidität und deren Ausscheidung nach vollendeter Schwangerschaft. *Wien. klin. Wchnschr.*, 1912, 25, 1557-1562.
12. HUCHARD, H. Colique hépatiques et coliques néphrétiques de la grossesse et de l'accouchement. *Union méd.*, 1882, 3. s., 33, 616; 649.
13. LEVYN, L., BECK, E. C., and AARON, A. H. Cholecystography in the late months of pregnancy. *Radiology*, 1928, 11, 48-55.
14. MANN, F. C., and HIGGINS, G. M. Effect of pregnancy upon the emptying of the gallbladder. *Proc. Soc. Exper. Biol. & Med.*, 1927, 24, 930.
15. MYERS, VICTOR C. Chemical changes in the blood in disease. *J. Lab. & Clin. Med.*, 1919-1920, 5, 776.
16. OSER, B. L., and KARR, W. G. The lipid partition in blood in health and in disease. *Arch. Int. Med.*, 1925, 36, 507-515.
17. PETERS, JOHN P., and VAN SLYKE, DONALD D. Quantitative Clinical Chemistry. Williams and Wilkins Co., Baltimore, 1931, p. 247.
18. ROTHSCHILD, M. A., and ROSENTHAL, S. M. Quoted by J. J. R. McCleod, in: Physiology and Biochemistry in Modern Medicine. Fourth edition. London, 1923-1924.
19. SLEMONS, J. M., and STANDER, H. J. The lipoids of maternal and fetal blood at the conclusion of labor. *Johns Hopkins Hosp. Bull.*, 1923, 34, 7-10.
20. TYLER, MARGARET, and UNDERHILL, F. P. The influence of pregnancy upon the lipoids of the blood. *J. Biol. Chem.*, 1925, 66, 1-14.
21. WILENSKY, A. O., and ROTHSCHILD, M. A. Studies in cholelithiasis. IV. The late and permanent results of the various types of operation on the biliary passages with especial reference to the cholesterol metabolism. *Am. J. M. Sc.*, 1924, 168, 66-77.



ILEOCECAL TUBERCULOSIS AND THE DOUBLE CONTRAST ENEMA EXAMINATION*

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IN A preliminary report,¹ a review was made of the recent advances in the diagnosis of ileocecal tuberculosis and the rôle played by the two main roentgen methods of study, namely, the mouth meal and the single contrast enema of barium sulphate suspension. Special reference was made to the use of the newer double contrast barium enema examination in these studies and now, in this report, an analysis is made of 102 consecutive cases, studied completely by the mouth meal, simple and double contrast enemas. These studies were made on patients admitted to Eagleville Sanatorium, Eagleville, Pa.; all suffering with pulmonary tuberculosis, with tubercle bacilli in the sputum. The pulmonary processes ranged from incipient to far-advanced lesions and were of diverse types. Many of the advanced cases have died and were autopsied during these studies, affording us an opportunity to check the accuracy of our roentgen findings. Very little was learned, either by surgery or autopsy, in those cases of *early* intestinal tuberculosis where we were so anxious to check our roentgen findings. We had to content ourselves with correlating the post-mortem and roentgen findings of fresh or early processes, often quite distal to the ileocecal areas, with those cases which came to autopsy in which the tuberculous ileocecal lesions were most frequently past the early stages. Our roentgen findings were further evaluated by studies of colons with early lesions removed from cadavers at the Philadelphia General Hospital, which were then examined by both enema methods.

Sampson has painstakingly advanced

the application and reliability of the mouth meal examination in the roentgen diagnosis of secondary ileocecal tuberculosis. We used his technique in the study of this series of patients and then checked the findings with those obtained with the single and double contrast enemas, the technique of which was modified from that first advocated by Fischer.

Considerable experience and training are necessary in the interpretation of the mouth meal films and unless one has a broad knowledge of normal roentgen appearances of the intestinal tract at different intervals after the mouth meal, many pitfalls present themselves. The diagnosis of early ileocecal tuberculosis by the mouth meal method depends almost solely on abnormal changes of motility of the barium column through the affected segments of bowel. Hypermotility in a segment of intestine in a tuberculous patient, revealed rather consistently in a series of films made between the seventh and tenth hour after ingestion, forms practically the keystone in the diagnosis of ileocecal tuberculosis, as worked out by Brown and Sampson.

In this series of 102 cases, 58 were negative and 44 were positive for evidence of secondary intestinal tuberculosis. Of the positive cases, 29 presented roentgen changes by the mouth meal examination, characteristic enough to establish the roentgen diagnosis, but 42 cases, about 30 per cent more, revealed roentgen signs by the enema studies from which we could make the diagnosis. On the other hand, in only 2 cases did the mouth meal studies reveal positive findings not obtainable by the enema examinations and in these cases, the lesions were confined practically to the jejunum and ileum. These lesions were also

¹ Gershon-Cohen, J. The diagnosis of early ileocecal tuberculosis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1930, 24, 367-388.

* These studies were made at the Isaac Paley Memorial Laboratory of Eagleville Sanatorium, Eagleville, Pa. (Dr. A. J. Cohen, Medical Director.)

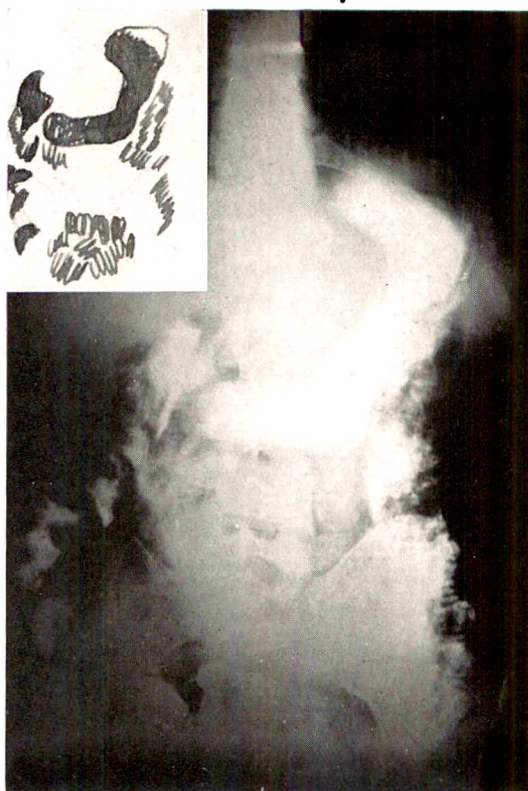


FIG. 1a. A case of early ileocecal tuberculosis. Patient is a female, aged twenty-three, with minimal proliferative tuberculosis of the right upper lobe, tubercle bacilli in sputum, Gaffky 1, with pulmonary symptoms of five months' duration. Intermittent digestive disturbances for the past three months, chiefly intermittent abdominal distention, constipation and diminished appetite. Studies with the mouth meal reveal no evidence of involvement of the ileocecal area while the barium enema studies reveal the presence of irritability, spasticity, hyperperistalsis and anastalsis in the cecum. This case was therefore regarded as having minimal tuberculous inflammation in the cecum. Five hours after mouth meal, a moderate gastric residue is present, the rest of the opaque contents being distributed in the duodenum, jejunum, ileum and colon, the head of the column having reached the hepatic flexure. Terminal ileum not filled. Ceco-colon irregularly filled.

probably old, having produced some stenosis and contraction of the lumen which caused stasis and dilatation in the proximal segments. The 15 cases that we diagnosed positive by only the enema findings were significantly only those cases with early lesions. It is true that abnormal

changes, usually hypermotile in nature, were seen in the roentgenograms of the mouth meal studies in this group, but these changes were not sufficiently constant or localized in the entire series of films to allow a trustworthy positive diagnosis. One was more inclined to regard them as possibly only borderline cases. Considerable broad experience is undoubtedly necessary for the correct interpretation in this group of cases and in other hands most of these cases, studied by the mouth meal, might be regarded as falling in the positive class. At any rate, we were more convinced with enema findings because these were easily obtained, definite and recordable. The colon with early acute inflammation seems to us to react in a manner more easily discovered by the enema examination than the mouth meal method.

The roentgen signs found in this group by enema examinations are localized spasm, intermittent hyperperistalsis and anastalsis, localized pain and tenderness,

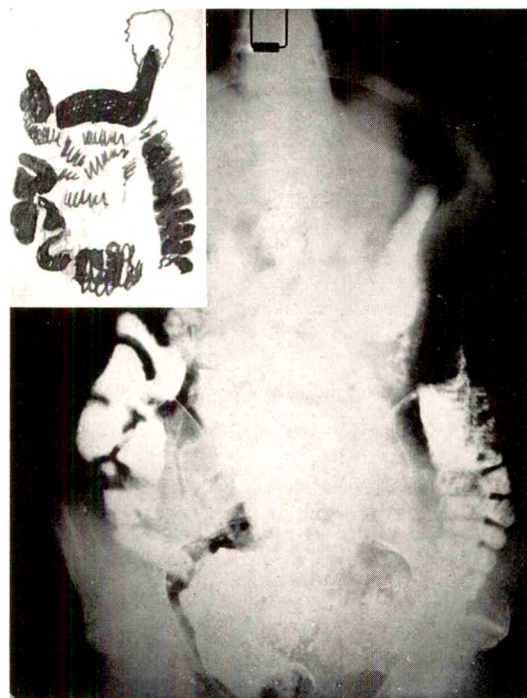


FIG. 1b. Same patient six hours after ingested meal. Terminal ileum well filled, the opaque contents being evenly distributed in the ceco-colon.

irregularity in the distribution of the residual opaque coating of barium on the inflamed portions of intestinal mucosa (visible only in the double contrast films), and least important, incompetency of the ileocecal valve. Ulcers can be detected, but only rarely. All these signs may not be found at the same time in any one case, neither are they of equal significance nor their frequency of occurrence invariable. One must also remember that these findings are not all pathognomonic of tuberculosis since inflammation from other causes can produce quite similar changes.

In the moderate and advanced cases of ileocecal tuberculosis, both methods of examination were found to yield unequivocal signs, only we gained a better insight into the extent and amount of involvement by the enema studies than by the

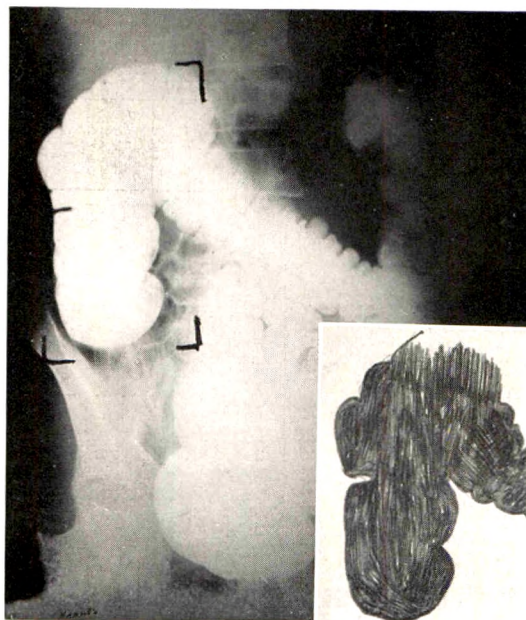


FIG. 1d. Same patient. Barium enema. No apparent filling defects in the cecum. Ileocecal valve competent, but there was intermittent spasticity, hyperperistalsis and anastalsis in the cecum.



FIG. 1c. Same patient eight hours after ingested meal. Slight gastric and duodenal residue, the rest of the opaque contents being distributed in the terminal ileum and colon, the head of the column having reached the splenic flexure. Terminal ileum apparently normally filled. Cecum and ceco-colon the seat of rather uniform heavy residue.

mouth meal examinations. An analysis of the roentgen findings after barium enema was therefore made to evaluate their usefulness (Table I).

Spasm. One does not expect to find persistent or intermittent localized spasm in the normal colon. Spasm and irritability of segments in the lower left colon are frequently encountered and although probably abnormal, one finds difficulty in attaching significance to the finding. It is the

TABLE I

Ileocecal Tuberculosis Methods of Study		
Cases Studied	102	
Positive cases (as determined by both Sampson and double contrast enema studies)	44	
Positive cases (as determined by enema studies alone)	42	96%
Positive cases (as determined by Sampson studies alone)	29	66%

TABLE II
SPASM (44 POSITIVE CASES) (58 NEGATIVE CASES)

Single Contrast Enema. Relation of Spasm to Location					Double Contrast Enema. Relation of Spasm to Location				
Positive					Positive				
Tonic	Inter-mittent	Total	Per-centage		Tonic	Inter-mittent	Total	Per-centage	
Cecum	34	40	91.0	6	19	25	56.8	3	5.1
Ceco-colon	16	17	38.6	0	7	10	22.7	2	3.4
Transverse	6	7	15.9	0	0	0		1	1.7
Descending	2	2	4.4	0	0	0		2	3.4
Sigmoid	7	7	15.9	1	0	0		2	3.4
Total	66	77	100.0	6	26	35	45.7	9	11.8
Percentage	91.5	98.6	100.0	7.8	67.6	91.4	100.0	22.2	28.9
Positive Cases					Positive Cases				
Spasm present in					Spasm present in				
Spasm absent in					Spasm absent in				
44					44				
36					26				
8					18				
81.3%					59.0%				
18.1%					40.0%				

Relation of Location to Spasm									
Positive					Negative				
Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Cecum	Ceco-colon	Transverse	Descending	Sigmoid
40	17	7	2	7	25	10	0	0	0
91.5	38.6	15.9	4.4	15.9	56.8	22.7	—	—	—
Total	40	17	7	2	25	10	0	0	0
Percentage	91.5	38.6	15.9	4.4	56.8	22.7	—	—	—
Positive Cases					Positive Cases				
Spasm present in					Spasm present in				
Spasm absent in					Spasm absent in				
44					44				
36					26				
8					18				
81.3%					59.0%				
18.1%					40.0%				

Relation of Location to Spasm									
Positive					Negative				
Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Cecum	Ceco-colon	Transverse	Descending	Sigmoid
40	17	7	2	7	3	2	1	2	2
91.5	38.6	15.9	4.4	15.9	5.1	13.4	1.4	3.4	3.4
Total	40	17	7	2	3	2	1	2	2
Percentage	91.5	38.6	15.9	4.4	5.1	13.4	1.4	3.4	3.4
Positive Cases					Positive Cases				
Spasm present in					Spasm present in				
Spasm absent in					Spasm absent in				
48					58				
8					8				
13.7%					13.7%				
86.2%					86.2%				

left colon that is generally involved in that rather broad class of "spastic" or "irritable" colons of neurogenic origin and in other diverse infectious processes like chronic ulcerative colitis, dysentery, amebiasis, chronic cathartic granular or follicular colitis and diverticulosis and diverticulitis. But the right colon, especially the ileocecal area, is the most usual site for tuberculous invasion. It is only exceptional that pathological processes, usually affecting the left colon, are found in the right colon and when they do occur there, rarely are they so advanced as in the left colon. Therefore, when one finds spasm or irritability of a segment of colon in the enema examinations, its association with some underlying abnormality is to be regarded as a probability and if its occurrence is in the ileocecal area, especially in a patient suffering with pulmonary tuberculosis

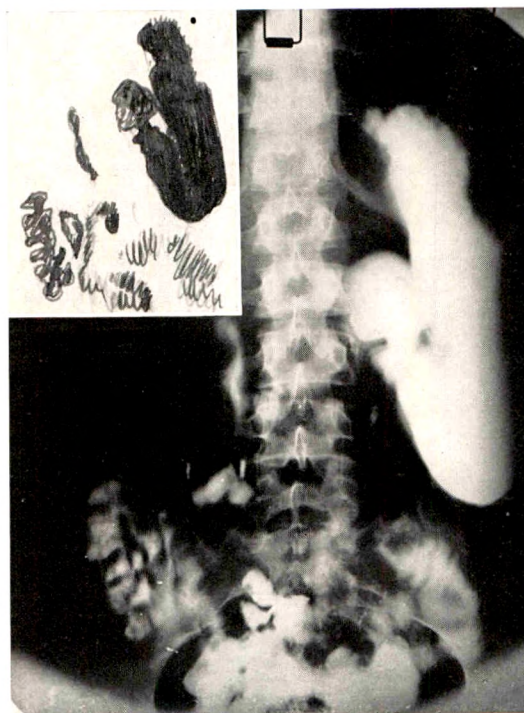


FIG. 2a. A case of late ileocecal tuberculosis. Patient is a male, aged sixty-three, with advanced fibro-ulcerative cavernous tuberculosis of both upper lobes. Film five hours after ingested meal. Considerable gastric and duodenal residue, the rest of the opaque contents being distributed in the terminal ileum and colon, the head of the column having just passed into the ceco-colon.

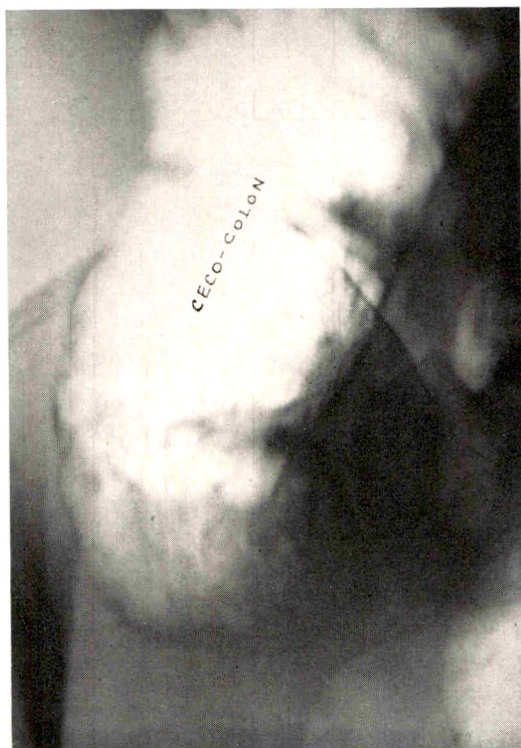


FIG. 1e. Same patient. Double contrast enema. Note the irregularity of the residual mucosal barium coating in the cecum as contrasted with the uniform barium coating in the ceco-colon.

with tubercle bacilli in the sputum, then tuberculosis in these intestinal segments must be strongly suspected (Table II).

Table II shows that spasm was found almost three times more frequently in the positive than in the negative cases when studied by the single contrast enema and almost five times more frequently with the double contrast enema. It is not the mere presence of spasm, however, but its location which is the more significant in the formulation of a diagnosis. Thus, one notes its occurrence in the single contrast enema in 40, or 91.5 per cent, of the positive cases in the cecum and with rapidly decreasing frequency in the distal segments. In the double contrast enema studies, its frequency of occurrence is generally less, but also in a significant manner, namely, in 25,

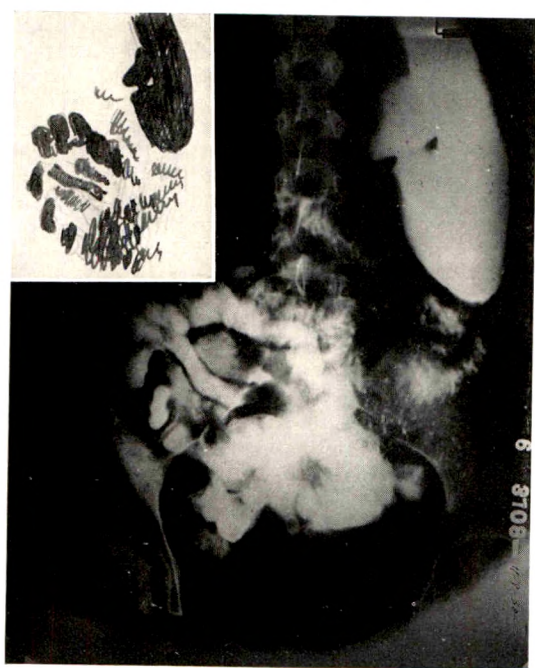


FIG. 2b. Same patient six hours after ingested meal. The head of the column has reached the hepatic flexure but the terminal ileum and proximal ceco-colon are poorly and irregularly filled.

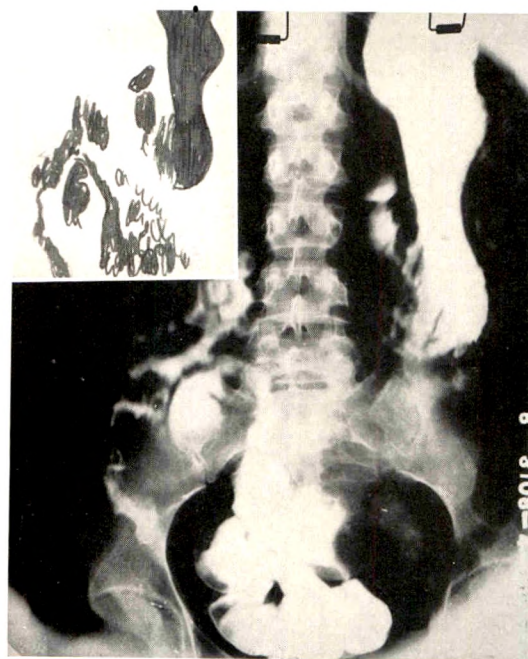


FIG. 2c. Same patient eight hours after ingested meal. The head of the column has reached the splenic flexure. The terminal ileum and ascending colon are still poorly and irregularly filled.

or 56.8 per cent, in the cecum and in 10, or 22.7 per cent, in the ceco-colon. This is in rather marked contrast to the findings in the 58 negative cases where spasm was revealed much more frequently in the left than in the right colonic segments, especially in the double contrast enema studies.

Hyperperistalsis and Anastalsis. It is notoriously rare to see colonic mass peristalsis during a mouth meal examination. Evidence of segmental hyperfunction resulting in increased motility is far more frequently obtained only from the serial roentgenograms than by the roentgenoscopic examination, when using the mouth meal method. During the enema examinations, however, its occurrence is frequently noted as seen in Table III. What was said about spasm applies more or less directly to the occurrence and location of abnormal peristalsis during the enema examinations. It occurred most frequently in the cecum and ceco-colon in early ileocecal tuberculosis.

One of the most common omissions in the enema study of the colon is failure to examine the patient after evacuation. This is fortunately impossible with the double contrast enema studies. It is natural not to expect an inflamed irritable segment of colon to retain injecta and in Table IV the cecum was the site of retained opaque injecta twice as frequently in the negative as in the positive group. If only the early positive cases were compared with the negative group, the difference should be even more striking. In late ulcerative or hyperplastic tuberculous colitis with much fibrosis, scar tissue formation and rigidity of the colonic walls, it is almost the rule to find a residuum of opaque contents in the involved segments. More generally, it is only in the early positive cases that irritability, hyperperistalsis and hypermotility of the involved segment is present and thus, more or less complete evacuation of the opaque injecta is seen in the affected areas during the intermediate examination.

Abnormal Changes in Residual Mucosal Coating of Barium. In a normal colon, the double contrast enema roentgenograms reveal a uniform coating of residual barium suspension on the colonic mucosa, but in transudative muco-spastic conditions or in inflammatory exudative processes, there are rather characteristic changes in this uniformity. This is one of the most helpful of aids furnished by the double contrast studies. One relies on it more and more as his experience broadens. In Table v, of the 44 positive cases, 35, or 79.5 per cent, reveal some change in the uniformity of residual mucosal coating in the cecum and 19, or 43.1 per cent, in the ceco-colon; this is a remarkable contrast to its occurrence in 58 negative cases where it was noted in only 4 cases, or 6.8 per cent, in the cecum and ceco-colon. The changes of uniformity

of coating depend on the nature and distribution of the underlying pathological changes. It seems unfortunate that ulcer is so rarely visible. This occurs only when a collection of barium residuum gathers under the overhanging edges or in the crater. Usually, a mosaic streaky arrangement of the residuum is visible in an inflamed area, making a rather sharp contrast to the uniformly coated adjacent normal segments. The marginal profiles instead of being sharply contrasted, etched-like white lines, as in the normal segments of colon, vary irregularly in the degree of visible distinctness, smoothness and continuity. Although these changes are no more characteristic for tuberculous than other inflammatory forms of colitis, except possibly chronic ulcerative colitis, the location of these changes helps in the diagnosis because

TABLE IV
INTERMEDIARY STUDIES

Relation of Residual Stasis to Location							
Positive				Negative			
	Total	Percentage		Total	Percentage		
Cecum.....	10	22.7	Cecum.....	26	44.8		
Ceco-colon.....	18	40.9	Ceco-colon.....	31	53.3		
Transverse.....	9	20.4	Transverse.....	12	20.6		
Descending.....	20	45.5	Descending.....	24	41.3		
Sigmoid.....	11	25.0	Sigmoid.....	17	29.3		
Rectum.....	8	18.0	Rectum.....	12	20.6		
Ileum.....	5	11.4	Ileum.....	11	18.9		

Relation of Location to Residual Stasis							
Positive				Negative			
	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum	Ileum
Total.....	10	18	9	20	11	8	5
Percentage....	22.7	40.9	20.4	45.5	25.0	18.0	11.4
Positive Cases	44						
Residue present in				36	75%		
Residue absent in				12	25%		

Relation of Location to Residual Stasis							
Positive				Negative			
	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum	Ileum
Total.....	26	31	12	24	17	12	11
Percentage....	44.8	53.3	20.6	41.3	29.3	20.6	18.9
Negative Cases	58						
Residue present in				46	79.3%		
Residue absent in				12	20.7%		

TABLE V

CHANGES IN UNIFORMITY OF RESIDUAL BARIUM COATING ON MUCOSA IN DOUBLE CONTRAST FILMS

Relation of These Changes to Location						
Positive			Negative			
	Total	Percentage		Total	Percentage	
Cecum.....	35	79.5	Cecum.....	4	6.8	
Ceco-colon.....	19	43.1	Ceco-colon.....	4	6.8	
Transverse.....	8	18.1	Transverse.....	7	12.0	
Descending.....	10	22.7	Descending.....	7	12.0	
Sigmoid.....	7	15.9	Sigmoid.....	3	5.1	
Rectum.....	0	0	Rectum.....	3	5.1	

Relation of Location to Changes in Uniformity of Coating						
Positive						
	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum
Total.....	35	19	8	10	7	0
Percentage.....	79.5	43.1	18.1	22.7	15.9	0
Positive Cases.....	44					
Changes in uniformity of coating present in.....	40 90.9%					
Uniform coating present in.....	4 9.0%					

Negative						
	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum
Total.....	4	4	7	7	3	3
Percentage.....	6.8	6.8	12.0	12.0	5.1	5.1
Negative Cases.....	58					
Changes in uniformity of coating present in.....	13 22.4%					
Uniform coating present in.....	45 77.5%					

tuberculosis is so often only confined to the ileocecal area.

In Table VII, an analysis is made of relation of pain and tenderness to location. The findings speak for themselves. It is only pertinent to add that each patient was also examined for the presence of intercostal neuralgia by the method advocated by Carnett in order to study them separately later. Worth mentioning also is the fact

that when a roentgenologist palpates with a kid gloved hand under the roentgenoscopic screen, he can more accurately determine the localization and relationship of pain and tenderness to the affected segment or organ than the unaided clinician.

The finding of incompetency of the ileocecal valve has been of no particular aid in the diagnosis of ileocecal tuberculosis, as shown in Table VI. This was

TABLE VI

Incompetency of Ileocecal Valve						
	Incompetent		Competent		Incompetent	
	Immediate	Delayed			Immediate	Delayed
Total.....	25	8	11	Total.....	25	10
Percentage.....	56.8	18.1	25.0	Percentage...	43.1	17.2



FIG. 2d. Same patient nine hours after ingested meal. Considerable gastric residue still present. The head of the column reached the rectum, the patient having had a bowel movement before the examination. Residue fairly uniform in the proximal transverse colon; terminal ileum and right ascending colon practically completely evacuated.

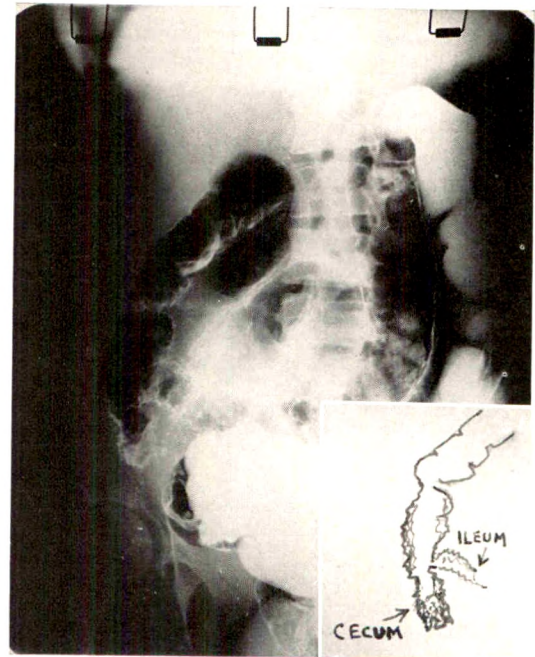


FIG. 2f. Same patient. Double contrast enema. Shows the amount of contraction and irregularity involving the terminal ileum, cecum and ceco-colon. Changes in the distribution of the mucosal barium coating in the involved areas and hyperplastic tissue are distinctly visible in the lumen of the ascending colon near the hepatic flexure. Compare the uniformity of the barium coating of the margins of the involved ascending colon with the uninvolved descending colon.



FIG. 2e. Same patient, barium enema. Marked contraction of the cecum and proximal ceco-colon with irregularity of the contour and margins partly obliterated by redundancies of the proximal transverse colon and sigmoid.

somewhat surprising to us because before actually making this analysis, its occurrence seemed more frequent in positive than in negative cases.

Thus far, this report has been limited to the analysis of signs as they occur in early cases of ileocecal tuberculosis, the group with which we should be most concerned if successful therapeutics is to be obtained. In the moderately and far-advanced cases, all methods with the mouth meal or either of the enema studies reveal characteristic changes that have already been well elaborated. It might be added, however, that the double contrast enema roentgenograms often reveal additional intraluminal pathological changes not visibly accessible in the opaque barium column of the single contrast enema or mouth meal roentgenograms. These supplementary changes

TABLE VII
PAIN AND TENDERNESS ALONG COURSE OF COLON

Relation of Pain and Tenderness to Location											
Single Contrast Enema						Double Contrast Enema					
Positive			Negative			Positive			Negative		
Total	Percentage		Total	Percentage		Total	Percentage		Total	Percentage	
Cecum.....	23	52.2	5	8.6		21	47.7		3	5.1	
Ceco-colon.....	14	31.8	2	3.4		11	25.0		1	1.7	
Transverse.....	0	0	0	0		1	2.2		0	0	
Descending.....	0	0	2	3.4		0	0		1	1.7	
Sigmoid.....	0	0	0	0		0	0		0	0	
Rectum.....	0	0	0	0		0	0		0	0	
Total.....	23										
Percentage.....	52.2										
Relation of Location to Pain and Tenderness											
Single Contrast Enema						Double Contrast Enema					
Positive			Negative			Positive			Negative		
Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum
23	14	0	0	0	0	3	1	0	1	0	0
52.2	31.8	0	0	0	0	5.1	1.7	0	1.7	0	0
Total.....	23										
Percentage.....	52.2										
Positive Cases						Negative Cases					
Cases where pain or tenderness was present						Cases where pain or tenderness was present					
35						58					
79.5%						8.6%					
Cases where pain or tenderness was absent						Cases where pain or tenderness was absent					
9						53					
20.4%						91.3%					

have already been dealt with in the preliminary report.

SUMMARY

The studies with the single and double contrast enema afford an easier, quicker, less expensive and more reliable method for the diagnosis of early ileocecal tuberculosis than the mouth meal method. This conclusion is soundly based on our studies at Eagleville Sanatorium. An analysis of 102 consecutive cases of pulmonary tuberculosis with tubercle bacilli in the sputum is made in this report, which shows the rela-

tion of the various roentgen signs, their frequency of occurrence and their location in 44 positively and 58 negatively diagnosed cases of ileocecal tuberculosis. Because the enema studies reveal these signs with greater diagnostic accuracy than the mouth meal studies in these early cases, its routine use is found more practical and satisfactory. The mouth meal method was found to have its greatest usefulness as a supplementary examination in those cases with intestinal symptoms and negative enema findings where lesions were confined to the jejunum and ileum.



THE APPENDIX, MORPHOLOGICALLY CONSIDERED*

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THE physiological and anatomical characteristics of the appendix offer definite obstacles to complete roentgen study. The uncertainty of obtaining within a reasonable time a satisfactory roentgenogram of the appendix unobscured by adjacent viscera has markedly limited its use, particularly in the acute and subacute pathological states.

Roentgenologists have reported successful filling of the appendix in 70-90 per cent of the non-acute cases. In a series of routine gastrointestinal studies of 141 consecutive (non-operated) patients we were able to visualize the appendix at the six, twenty-four, forty-eight, or seventy-two hour interval in 72 per cent. By further study, that is, after the barium clyisma, after evacuation of, or six or twenty-four hours after the clyisma, or after sediment mixture ingestion following catharsis, this percentage was increased to 90.



FIG. 1. Case 1. Non-pathological appendix at 28½ hour interval.

While this frequency of appendicial visualization may suffice, the method proved decidedly impractical, necessitating in the exceptional case nine or ten roentgenoscopic observations with con-

siderable manipulation and consuming more than a week in which to complete the examination. At the outset, therefore, we are faced with the chief obstacle to

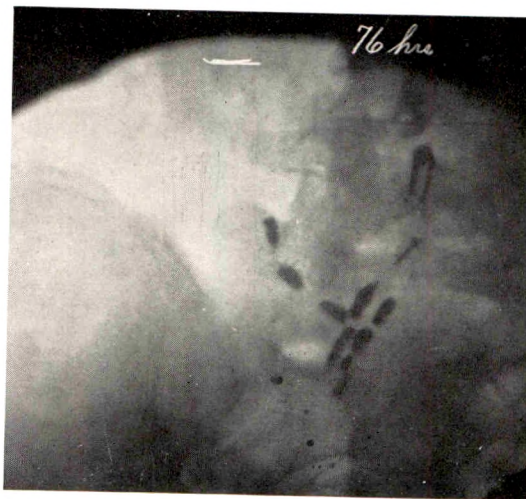


FIG. 2. Case 1. Non-pathological appendix at 76 hours.

thorough appendicial investigation and until more suitable means can be devised further progress seems unlikely.

Among the common causes of non-filling of the appendix with the opaque mixture may be considered:

1. Physiological non-visualization—
Appendix having been filled with opaque ingesta and evacuated prior to observation.
2. Obstructed lumen—
 - A. Normal appendicial feces or concretions.
 - B. Spasm at ostium or possibly of shaft.
 - C. Pathological obliteration of lumen.

Roentgen evidence of appendicial pathology. At present the most generally accepted roentgen evidence of inflam-

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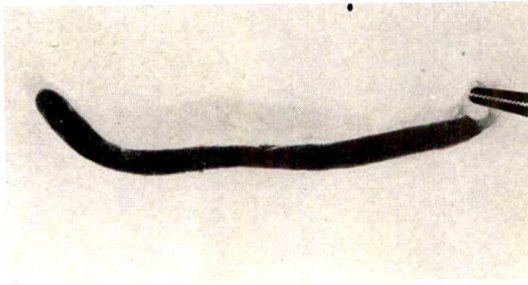


Fig. 3. Case I. Non-pathological appendix after injection, post operation.

mation is unquestionable tenderness or referred pain elicited on palpation over the appendix in its assumed and in its misplaced position during roentgenoscopic manipulation.

Reflex phenomena, while not characteristic of, may be associated with pathology of the appendix; extrinsic spasm may be found along the alimentary tract particularly at the pylorus, duodenal, duodenojejunal, ileocecal and cecocolic areas.

The position and length of the appendix may be readily determined by direct observation. Undoubted fixation of the shaft or tip of the appendix or persistently deformed shape indicates involvement of its serosa by adhesions. Interval examinations until complete evacuation of its contents provide data concerning motility. In brief, the roentgen examination to date has been limited, more or less, to the indirect evidence of disease. Consequently studies of the appendical lumen have recently been instituted to ascertain the characteristic filling defects, if any, of the various pathological states

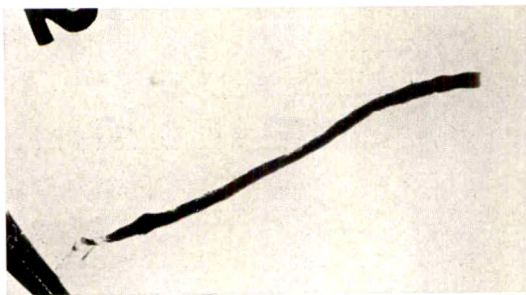


FIG. 4. Case II. Atrophic appendix.

involving this organ. These examinations were made of the filled appendix in vivo and after removal at operation or post mortem.

The normal appendix. The shadow of the normal lumen is uniform in density and width from its ostium to tip, with the following exceptions.

1. Presence of fecal contents unmixed with opaque material.
2. Inspissated opaque ingesta which has become fragmented apparently by longitudinal muscular relaxation.
3. Partial evacuation—proximal portion first evacuated.
4. Intrinsic muscular contraction.

The pathological appendix. Certain abnormal changes of the wall of the appendix

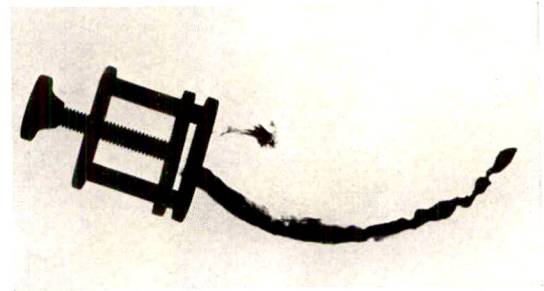


FIG. 5. Case III. Atrophic appendix with fibroblastic changes.

produce definite deformities of the lumen which roentgenographically appear characteristic of such pathology. Edema and infiltration of the mucosa and submucosa produce slight irregularities of the wall contour varying with the degree of pathology. In the more virulent infection destruction of the appendical wall may be distinguished by the presence of barium in the deeper layers.

At times there may be observed small hemispherical indentures of the lumen which suggest spasm of the circular muscular coat.

In certain acute stages, portions of the lumen may be completely occluded by pathological changes within the wall and the retention of debris and inflammatory

products. Occlusion of the lumen also occurs, though more completely in chronic obliterating appendicitis in which non-visualization of the appendix occurs. Strictures of the lumen of more or less regular outline appear to result from fibrosis of the wall with contracture.

Recognition of a minor degree of cellular infiltration, on which a questionable pathological report of chronic appendicitis may be made, is impossible by study of the luminal shadow; such changes, however, are microscopical and whether they may be considered symptom-producing is controversial. The following cases demonstrate certain of the characteristic luminal shadows noted after injection:

CASE I. G. R., female, aged sixteen. Complaint, vague pain throughout right lower

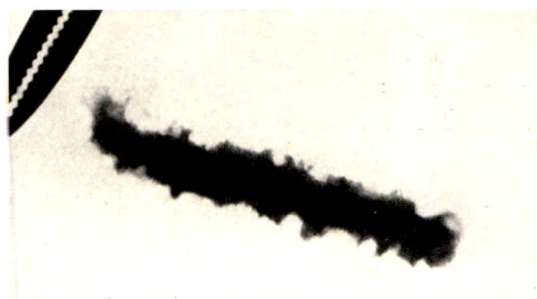


FIG. 6. Case IV. Acute exudative appendicitis.

quadrant; roentgenoscopically no evidence of appendicial pathology. The appendix is filled twenty-eight hours after ingestion of opaque meal; lumen uniformly filled except for small area proximal to tip; lumen of regular contour (Fig. 1). At seventy-six hours barium column fragmented; change of shape and position of appendix (Fig. 2). Figure 3—after surgical removal; appendix now contains freshly injected opaque mixture in addition to that which has been retained from barium meal; note regularity of contour of lumen. Pathological report—no evidence of inflammatory changes.

CASE II. M. C., female, aged fifty-six. Chief complaint, pain in the back. Onset of symptoms about five months ago with prolapse of the uterus. Inability to control urinary bladder. Appendectomy incidental to gynecological operation. No appendical history. Roentgen-

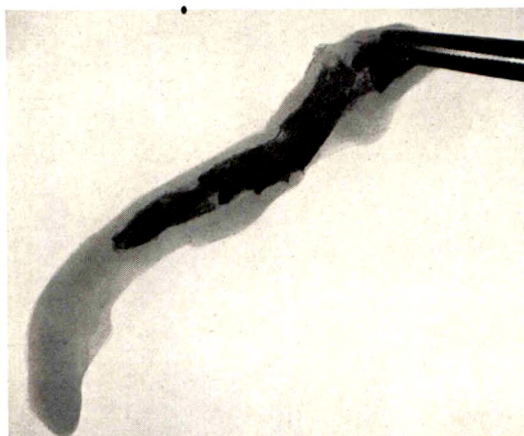


FIG. 7. Case V. Acute necrosing appendicitis.

ogram of the appendix after filling of the specimen with barium reveals an abnormally narrow lumen of practically regular contour throughout its entire course (Fig. 4). Pathological report: Mucosa destroyed; slight adiposis; marked atrophy of all coats.

CASE III. S. C., female, aged twenty-three; white, houseworker. Pains in the lower abdomen on and off for the past three years preceded by a copious vaginal discharge which has lately improved under treatment. Five weeks ago patient noticed a creamy yellow discharge and a week later pain again began to develop in the lower abdomen, growing in intensity as time elapsed. Diagnosis: bilateral salpingo-oophoritis. Appendectomy incidental to operation. Roentgenogram (Fig. 5) discloses irregular defect along one wall of the proximal half of the appendix (detritus); the

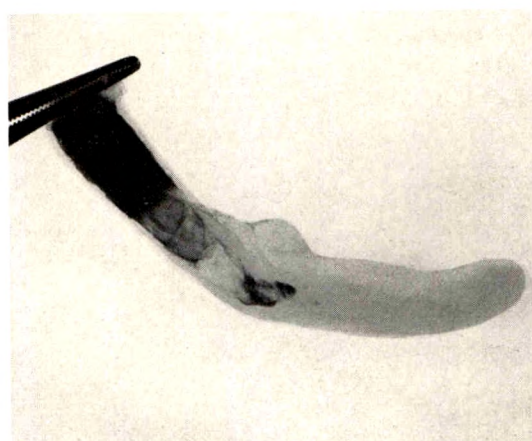


FIG. 8. Case VI. Acute exudative appendicitis of distal shaft; lumen occluded by concretions.



FIG. 9. Case VII.

distal end presents well defined indentures of the lumen. Pathological report: chronic appendicitis. Section (a) of the proximal half shows fecal detritus; (b) of the distal end shows atrophic changes on one side of the lumen and fibroblastic hyperplasia opposite same which encroaches on the lumen.

CASE IV. E.B., aged thirty-seven, housewife. Chief complaint, pains in the right lower quadrant. No previous attacks. Present attack—acute onset two days prior to operation. White blood cells, 9,000; polymorpho-

nuclears, 68 per cent. Roentgenogram (Fig. 6) after injection of barium post-appendectomy reveals: a short appendix with multiple superficial irregularities and deeper hemispherical indentures. Pathological diagnosis: exudative appendicitis; marked congestion and edema with prominence of goblet cells in the mucosa and submucosa; invasion of all the coats by polymorphonuclear cells.

CASE V. D.I., aged twenty-two. History of acute pain in the right lower quadrant and vomiting. Roentgenogram (Fig. 7) of the specimen post-appendectomy reveals: a $4\frac{1}{2}$ inch long appendix, two-thirds of which can be filled with barium. Barium column is of non-uniform density, several small areas of extraluminal filling (necrosis); lumen of distal third is occluded probably by inflammatory products and infiltration of walls. Pathological report: acute necrosing appendicitis. Areas of necrosis of the mucosa and replacement by purulent exudate. Mucosa shows more destruction in the middle section than in the proximal end. Pus and free blood are in the lumen.



FIG. 10. Case VII. Postoperative specimens in Ringer's solution.

products. Occlusion of the lumen also occurs, though more completely in chronic obliterating appendicitis in which non-visualization of the appendix occurs. Strictures of the lumen of more or less regular outline appear to result from fibrosis of the wall with contracture.

Recognition of a minor degree of cellular infiltration, on which a questionable pathological report of chronic appendicitis may be made, is impossible by study of the luminal shadow; such changes, however, are microscopical and whether they may be considered symptom-producing is controversial. The following cases demonstrate certain of the characteristic luminal shadows noted after injection:

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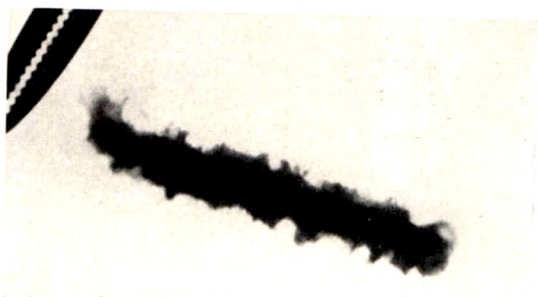


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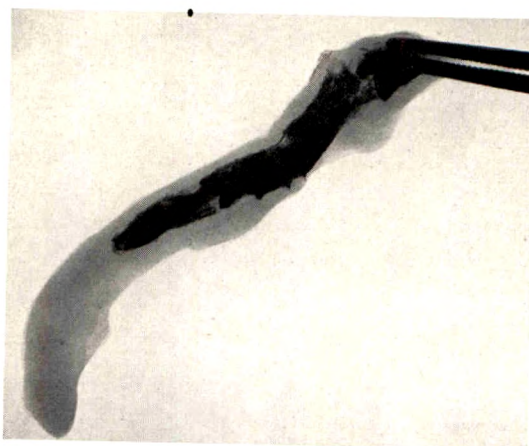


FIG. 7. Case V. Acute necrosing appendicitis.

ogram of the appendix after filling of the specimen with barium reveals an abnormally narrow lumen of practically regular contour throughout its entire course (Fig. 4). Pathological report: Mucosa destroyed; slight adiposis; marked atrophy of all coats.

CASE III. S. C., female, aged twenty-three; white, houseworker. Pains in the lower abdomen on and off for the past three years preceded by a copious vaginal discharge which has lately improved under treatment. Five weeks ago patient noticed a creamy yellow discharge and a week later pain again began to develop in the lower abdomen, growing in intensity as time elapsed. Diagnosis: bilateral salpingo-oophoritis. Appendectomy incidental to operation. Roentgenogram (Fig. 5) discloses irregular defect along one wall of the proximal half of the appendix (detritus); the

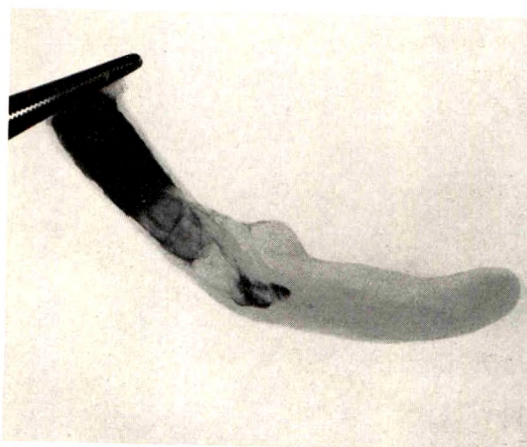


FIG. 8. Case VI. Acute exudative appendicitis of distal shaft; lumen occluded by concretions.



FIG. 9. Case VII.

distal end presents well defined indentures of the lumen. Pathological report: chronic appendicitis. Section (a) of the proximal half shows fecal detritus; (b) of the distal end shows atrophic changes on one side of the lumen and fibroblastic hyperplasia opposite same which encroaches on the lumen.

CASE IV. E.B., aged thirty-seven, housewife. Chief complaint, pains in the right lower quadrant. No previous attacks. Present attack—acute onset two days prior to operation. White blood cells, 9,000; polymorpho-

nuclears, 68 per cent. Roentgenogram (Fig. 6) after injection of barium post-appendectomy reveals: a short appendix with multiple superficial irregularities and deeper hemispherical indentures. Pathological diagnosis: exudative appendicitis; marked congestion and edema with prominence of goblet cells in the mucosa and submucosa; invasion of all the coats by polymorphonuclear cells.

CASE V. D.I., aged twenty-two. History of acute pain in the right lower quadrant and vomiting. Roentgenogram (Fig. 7) of the specimen post-appendectomy reveals: a $4\frac{1}{2}$ inch long appendix, two-thirds of which can be filled with barium. Barium column is of non-uniform density, several small areas of extraluminal filling (necrosis); lumen of distal third is occluded probably by inflammatory products and infiltration of walls. Pathological report: acute necrosing appendicitis. Areas of necrosis of the mucosa and replacement by purulent exudate. Mucosa shows more destruction in the middle section than in the proximal end. Pus and free blood are in the lumen.



FIG. 10. Case VII. Postoperative specimens in Ringer's solution.



FIG. 11. Case VII. Same specimens as shown in Figure 10 after addition of pilocarpine.

Other coats show marked vascular reaction and infiltration. Distal portion shows no lumen. No lymphoid follicles are evident and the entire wall of the appendix here is likewise infiltrated with pus cells.

CASE VI. M.P., male, aged forty. Very acute attack, vomiting and pain in the right lower quadrant. White blood cells, 20,600; polymorphonuclears, 79 per cent. Figure 8 shows specimen of the appendix 5.8 cm. long; well filled in its proximal portion, showing wide lumen with large central defect (concretions) in the mid-portion occluding the lumen. Pathological report: acute exudative appendicitis. Longitudinal section of the appendix: Marked edema of the mucosa and submucosa and atrophy of the muscularis in the distal portion; there is marked degeneration of the mucosa and atrophy of the muscularis in the mid-portion, corresponding to site of concretions.

CASE VII. B.R., aged thirty-four. Appendectomy incidental to operation for cystic ovary. Roentgenogram (Fig. 9) reveals a

well-filled lumen through the entire appendix with numerous extraluminal collections of opaque mixture and several dense bands extending transversely across the shaft. A satisfactory explanation has not yet been offered for this unusual finding. Pathologically, a slight degree of fibroadiposis only was noted; however, a transverse section only was studied. Since this occurrence longitudinal sections of the entire appendix have been made.

To study the activity of the appendix, specimens were partially filled and treated after the method of Rössle. Appendices in Ringer's solution (Fig. 10); same specimens (Fig. 11) within one minute after the addition of 1-1000 pilocarpine solution. Note marked change in shape; in the well-filled organs the contents of the proximal shaft are evacuated during this activity.

In concluding, it may be stated that preliminary study of the luminal shadows of normal and diseased appendices indicates

that the deformities produced seem characteristic of certain underlying pathological states. While satisfactory visualization of the appendix, particularly in the acute and subacute inflammatory stages, appears at this time quite hopeless, the valuable information to be gained

justifies attempts to surmount the obstacles which thus far have impeded complete roentgenological investigation of this organ.

Acknowledgment is made of the kind assistance of the pathologists, Drs. William Hala and Berthold Comeau.

REFERENCES

1. ASCHOFF, L. Wurmfortsatzentzündung. G. Fischer, Jena, 1908.
2. CAMBIÈS. Nuovo método de exploración radiológica del apéndice. *Semana méd.*, 1928, 1, 676-680.
3. CZEPA. Die Fullbarkeit der Appendix. *Verhandl. aerztl. Gesellsch.*, Wien, 1926.
4. CZEPA, A. Beiträge zur Röntgendiagnostik der Appendix. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1927, 36, 60-95.
5. EASTMOND, C. Roentgen diagnosis of pathological appendix. *Med. Rec.*, 1921, 100, 677.
6. JAISON, C. Étude radiologique de l'appendice dans l'appendicite chronique. *J. de radiol. et d'électrol.*, 1921, 5, 256-263.
7. RÖSSLE, R. Die Beweglichkeit des Wurmfortsatzes. *Beitr. z. path. Anat. u. z. allg. Path.*, 1927, 77, 121-140.
8. ROYSTER, H. A. Appendicitis. D. Appleton Co., New York, 1927.
9. WESTPHAL, K. Die Pathologie der Bewegungsvorgänge des Darmes. In: *Handb. d. normalen u. path. Physiol.*, Band III, p. 483.



SEPARATION OF THE SYMPHYSIS PUBIS

WITH REPORT OF FIVE CASES

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THIS paper is presented to direct further attention to a condition which has in the past received little consideration, probably because of its comparatively infrequent occurrence and its even less frequent recognition. The incapacity and impairment of locomotion caused by separation of the pubic bones with its associated sacroiliac injury are often sufficiently marked to merit greater interest and more careful study.

Separation of the symphysis pubis probably occurs more frequently than at least the older statistics would indicate, which will, no doubt, be demonstrated by more careful examination of patients, particularly in those following difficult or complicated labor and especially by more frequent use of the roentgen ray.

HISTORY

The ancients taught that the pelvic joints always softened during pregnancy and opened during labor, so that the fetus could readily pass through. They also ascribed difficult labor to too great rigidity of these joints. Later, the opposite condition was believed to be normal, and those in whom relaxation of the pelvic joints occurred were considered morbid.

De Lee⁶ believed the ancients must have reasoned from analogy, having observed the softening of the joints in cows and other animals; the "sinking of the rump" and the difficulty of locomotion of the cow show the veterinarian that the animal is near term. In guinea pigs the pelvic ligaments soften and allow separation of the pubic bones as much as one inch, and the legs may even be laid flat alongside the animal; after labor, the joints again become normal.

ETIOLOGY

Separation of the symphysis pubis may be divided into two general classes: (a) those complicating childbirth, comprising the great majority, and (b) severe trauma, the result of train and automobile accidents, falls, etc., which are often complicated by serious visceral injuries and have a high mortality. This group is relatively small, and therefore less important.

Sparrow¹⁹ reports a case resulting from the wheel of an automobile resting upon the anterior superior iliac spines, causing a separation of 9 cm.

Schaanning¹⁸ reports a case in a pregnant woman near term, who slipped and fell on the street.

Willan²¹ reports 2 cases and Buckley⁴ one case, resulting from falls from horses.

Koven¹⁴ contributes another due to an automobile accident.

The earlier writers would lead us to believe that even the first group or those occurring during parturition are extremely rare; thus Kehrer¹³ was able to collect only 100 cases from the literature up to 1915.

Tuley²⁰ reports one case in 30,000 deliveries; Morgan¹⁷ 4 in 80,000; Kayser¹² 3 in 94,000 and Hirst and Wachs¹⁰ reported the occurrence of this complication 3 times in 94,149 labors.

More recently (1929) Wishner and Mayer²² of the Orthopedic Department of the Hospital for Joint and Bone Diseases, New York, have observed 5 cases in 1 year.

Five cases have come under our observation since 1927 at the Misericordia Hospital, one in a man, the result of an automobile accident, 2 following difficult forceps deliveries, one following spontaneous delivery, and one associated with a congenital dislocation of the left hip.

This separation was present on films made previous to any manipulation for reduction of the dislocated hip and is therefore definitely congenital and not as we at first thought due to the efforts at attempted reduction.

De Lee⁷ gives as contributing causes softening and relaxation of the capsule, caries, rachitis, congenital weakness of the ligaments, all of which have been found in such cases when even the distention of the pelvis during spontaneous delivery may cause the joint to give way. Contracted pelves, especially the justo minor and funnel varieties, because the expulsion force acts in the narrow transverse diameter predisposes to separation of the pubic bones. A large child or especially broad shoulders may act in the same way.

ANATOMY AND PHYSIOLOGY

The articulation between the pubic bones is an amphiarthrodial joint formed by the junction of their two articular surfaces. These bones are held together by four strong ligaments, anterior, posterior, superior and inferior (arcuate).

It is a debatable question whether or not slight motion exists in the joint normally. It is generally accepted, however, that during pregnancy there is a definite relaxation of softening of all the pelvic ligaments which may permit of a separation even before delivery.

Beach² reports a case in which this separation amounted to 7.5 cm. One case observed by us in 1927 had separation of 6 cm., as measured from a film made on the Potter-Bucky diaphragm. This was the result of a difficult forceps delivery.

MECHANICS OF SEPARATION

The cause of separation is no doubt due to the pressure effect of the advancing head on the pelvic ring, which gives at its weakest point. Frequently, forceps are a potent factor. Exceptionally during delivery, a distinct crack has been heard, suggesting an acute tear (MacPherson).

Lynch¹⁵ believes that there is a stretching of the ligaments rather than a tear.

Goldthwait and Osgood⁹ in 1905 reviewed the literature thoroughly, but were unable to find any allusion to such affections of the pelvic joints apart from pregnancy. They later were convinced that certain cases occur, in the absence of pregnancy, in connection with menstruation and finally they successfully applied the same considerations to explain certain cases of low back and leg pain and disability, occurring both in men and in women.

With the object of studying the sacroiliac joints, Chamberlain⁵ developed a technique for detecting and measuring the degree of movements of the pubic bones, which occurs with alteration of weight bearing from one leg to the other. First, normal individuals were studied, and he found movement at the pubes amounting to from 0 to 0.5 mm. in the male, and from 0 to 1.5 mm. in the non-pregnant female, and that movement of 2 mm. or more invariably caused symptoms.

When the pubic bones separate, there is necessarily a separation, at least in the anterior portion of one or both sacroiliac joints. This has been observed by myself and has been well worked out by Wishner and Mayer who studied the mechanism on a pelvis removed from a female cadaver with all the ligaments intact. After the pubic ring was cut through at the symphysis, the pubic bones were pried apart a distance of 4 cm. As this was being done, the anterior sacroiliac ligaments were seen to give way and the roentgenogram showed the joints gaped open about $\frac{1}{4}$ inch. Separation of from 0.3 to 0.9 cm. are considered by various observers normal following delivery.

CLINICAL PICTURE AND DIAGNOSIS

Most often following an unusually difficult labor, especially when high forceps are used, following delivery, pain is felt in the pubic region and lower back which radiates down the thighs. Difficulty in moving the

legs, even when in bed, is experienced. On getting up, the patients have greater pain and find walking very difficult. They may feel a definite separation and movement of the pubic bones with each step.

The objective signs are usually quite characteristic. The gait is a peculiar waddle, due to the instability of the pubic arch, and the malalignment of the hip joints to the body, and is frequently so typical that a diagnosis can be made from this alone. There is definite tenderness over the symphysis and one or more fingers may be inserted between the pubic bones. There may be tenderness over one or both sacroiliac joints. Motion may be demonstrated at the pubes, by manipulation of the legs and thighs.

The roentgenogram either makes or confirms the diagnosis. The associated separation of the sacroiliac joints is not always detectable on the film.

The technique for the roentgen examination, especially the relation of the pubic bones to the film, is of the utmost importance, if the measurements of the amount of separation are to be accurate. For example, on one of our patients, a film was made on a Potter-Bucky diaphragm in the anteroposterior position, and the separation measured 6 cm. (Fig. 2a). Another film was made at the same time, with the patient in the postero-anterior position, when the amount of separation measured only 4.75 cm. (Fig. 2b). For practical purposes, however, most valuable diagnostic information is obtained from films made in the anteroposterior direction, especially since most pelvic studies are made in this position, it being only necessary to bear in mind that there is a considerable exaggeration of the separation due to the position and also a slight exaggeration due to the Potter-Bucky diaphragm. By placing the cassette directly in contact with the symphysis, the patient lying on her abdomen, with a focal tube distance of 36 inches or more, very exact measurements may be obtained. Frequently, however, the condition of the pa-

tient in regard to pain and stage of puerperium render this last procedure impractical.

TREATMENT

Many methods have been suggested for treatment of this condition.

Boorstein³ reports 6 cases treated with adhesive plaster and belts with excellent results.

Allen¹ inserted a Lane plate. This did not hold and it had to be removed later. Through two small skin incisions, he then inserted two nails into the iliac spines allowing them to protrude above the skin. Strong wire was bound around these nails. A cast was applied, and after eight weeks the patient was able to walk.

McNamara¹⁶ closed the symphysis by passing No. 4 silver wire through the obturator foramen. This gave good results.

Boorstein and others recommend that the patient be placed on a Bradford frame to facilitate nursing care. A pillow is placed under the knees to relieve the drag of the extremities upon the pelvis, the knees being loosely bound together for the first week. A broad strap of adhesive plaster is applied to the pelvis. The ends are brought around in front and doubled back to provide a firm support for the insertion of a lacing of bandage or other material which is used to tie them together tightly in front of the pubis. Later, a webbing belt is used, encircling the body just above the level of the trochanters, and drawn firmly together in front by appropriate straps and buckles. If the gaping of the symphysis is very marked, a broad canvas sling or hammock should be passed under the pelvis and lower back, and the ends secured to the overhead beams of a Balkan frame. The pressure of the sling on the side of the pelvis from the patient's weight exerts a strong compression force on the bones which tends to push them together.

Holderman¹¹ uses a large, heavy leather belt sufficiently long to circle the pelvis, 7 cm. in width, and 0.3 cm. in thickness. On its inner surface, it is lined with felt, 0.5

cm. thick, and the felt is sufficiently wide to extend 0.75 cm. beyond the edge of the leather.

Complete recovery is variously estimated from a few weeks to six months, depending, at least to a large degree, upon the amount of separation present, and the promptness with which the treatment is instituted.

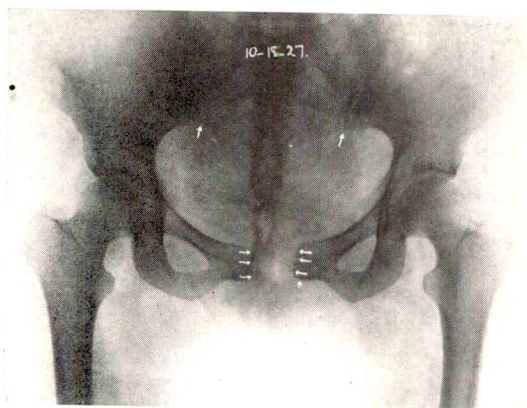


FIG. 1. Case I. Showing separation of the pubic bones of 3 cm. and also an increase in width of the sacroiliac joints. The left pubic bone is displaced upward 4 mm. This case resulted from a difficult forceps delivery.

CASE REPORTS

CASE I. Mrs. J. A., aged thirty-one, primipara. Born in Italy. Housewife by occupation. Was admitted to the Misericordia Hospital, October 7, 1927. Menses began at the age of thirteen, at 28-day intervals and lasted usually about five days. Her last period occurred in January, 1927. The only symptoms thereafter were early nausea and vomiting. Physical examination on admission revealed a young, healthy adult Italian, showing pregnancy approximately at term, the fetus in the L. O. A. position, vertex presenting. Pains began October 9, 1927, and were terminated twelve hours and seven minutes later after the application of forceps. The cervix and perineal floor were deeply lacerated. Excessive bleeding continued for several hours, which was controlled by packing and abdominal binder was applied. The patient complained bitterly of pain in the lower abdomen and lower back.

A roentgen examination was made October 14, which showed separation of the symphysis pubis of 3 cm., and an increase in the width of

the sacroiliac joints. There was upward displacement of the left pubic bone 4 mm. (Fig. 1). The pelvis was tightly encircled with adhesive plaster, which was allowed to remain in place until the patient was discharged, October 29, 1927. Walking caused only slight pain in the symphysis and sacroiliac region.

CASE II. Mrs. M. H., aged twenty-five, white, housewife, referred to the Roentgen Department because of difficulty in walking and pain in the pubic region and lower back. Her difficulties dated back one year, when she was delivered of a full term baby by forceps at home. This was her first pregnancy.

The roentgen examination showed separation of the pubic bones of 6 cm., as measured from a Potter-Bucky film, made in the anteroposterior direction (Fig. 2a), and measuring 4.75 cm. on a film made in the posteroanterior position (Fig. 2b). There was shown also very definite and moderately marked separation of both the sacroiliac joints. At the time of this examination, the patient was four months pregnant. Five months later, she delivered herself spontaneously of a full term baby. Previous to this second pregnancy, she complained of only slight pain in the lower abdomen and back, which be-

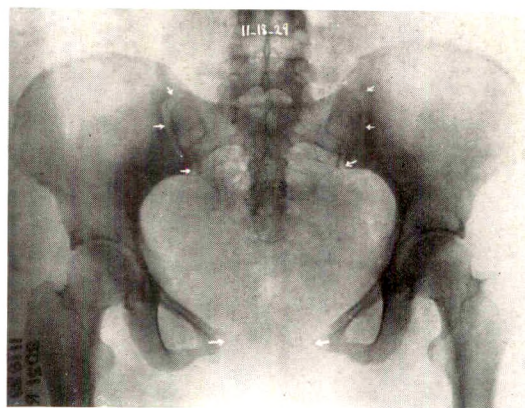


FIG. 2a Case II. The pubic bones are separated 6 cm. as measured from a film made on the Potter-Bucky diaphragm with the patient in the supine position. The sacroiliac joints also show definite subluxation, following difficult forceps delivery.

came aggravated after conception. Following delivery the pains again improved and the waddling gait was the principal complaint.

CASE III. Mrs. A. D., Italian, aged thirty-one, admitted to the Misericordia Hospital, September 13, 1927. Discharged after a normal spontaneous delivery, September 28, 1927.

In 1924, this patient had had a dead fetus removed at the fifth month. In 1925, she delivered herself spontaneously of a normal full term baby. Pains began at 11 A.M. on September 13, 1927. The membranes ruptured at 10:20 P.M. September 14. A normal, male baby was born spontaneously at 11:50 P.M. Duration of labor was 25 hours. She sustained a superficial laceration of the perineum, which required only one suture.

A roentgen examination was requested because of persistent pain in the symphysis, and revealed separation of the pubic bone 1 cm.,

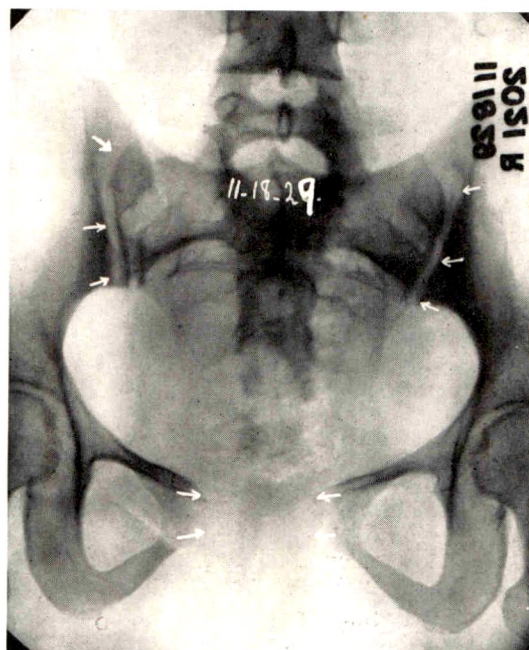


FIG. 2b. Case II. This film was made with the patient in the prone position, and the separation measured only 4.75 cm.

and upward displacement of the left pubic bone 3 mm. (Fig. 3). Slight pain produced by walking was present on discharge.

CASE IV. Male, aged sixteen, was referred to the Misericordia Hospital Roentgen Department, complaining of pain in the bladder region, which pain was greatly aggravated by walking. Three days previously, he was squeezed by an automobile against a garage door. The roentgen examination showed separation at the symphysis of 1 cm. There were no fractures present, nor was there any demonstrable disturbance in the sacroiliac joints (Fig. 4). This patient was treated at home, with a pelvic girdle of adhesive

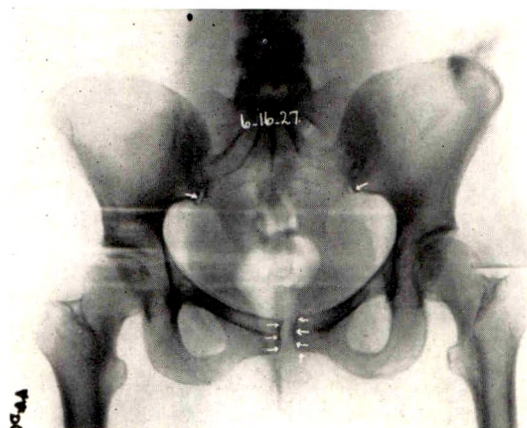


FIG. 3. Case III. Following a spontaneous delivery which lasted twenty-five hours. The pubic bones are separated 1 cm. and the left pubic bone is displaced upward 3 mm.

plaster tightly encircling the pelvis to below the level of the trochanters. After two weeks in bed, the patient was allowed up, and was completely free from symptoms.

CASE V. B. T., female, aged three. Referred to us March 17, 1930, with a diagnosis of congenital dislocation of the left hip.

The roentgen examination showed complete dislocation of the left femoral head, with marked internal rotation of the shaft of the femur. The left acetabulum is quite shallow and its roof is poorly developed. The remaining bones of the pelvis, including the femur, are

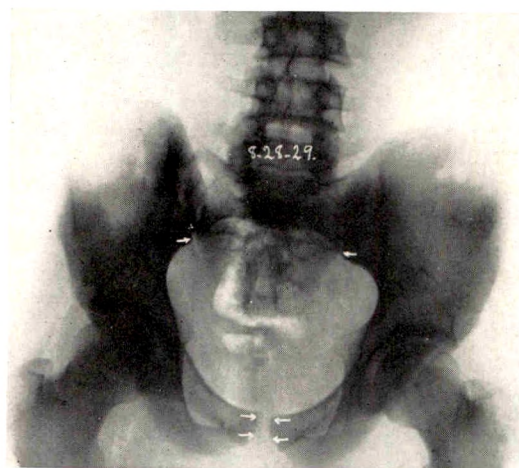


FIG. 4. Case IV. This patient was squeezed against a garage door by an automobile, resulting in a separation at the symphysis of 1 cm., with no evidence of fracture.

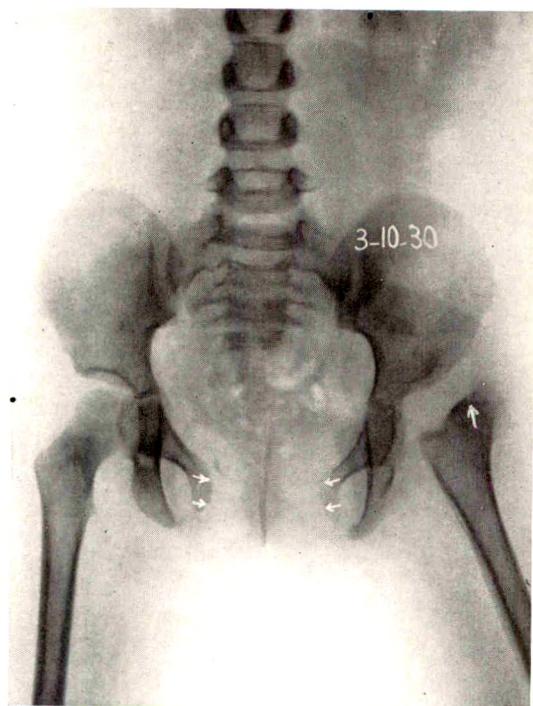


FIG. 5. Case v. Shows a congenital separation of the symphysis pubis associated with congenital dislocation of the left hip. Films were made of the pelvis previous to any manipulation of the left femur for reduction; this separation is therefore definitely congenital.

generally slightly less well developed on the left than on the right side. The pubic bones are separated to the extent of 4 cm., and the sacroiliac joints seem to be abnormally wide. The original films in this case were made before reduction of the dislocated hip was attempted. The separation at the symphysis is therefore undoubtedly congenital in origin.

Following reduction of the left hip by the closed method, a cast was applied with both thighs in extreme abduction.

The roentgen examination showed that the reduction of the dislocated hip was successful, and that there was no change in the separated pubic bones. A final film was made January 3, 1931, which showed partial dislocation of the left femoral head and the pubic separation identical with that shown by the original films (Fig. 5).

This last case is of special interest because in reviewing the literature only one other somewhat similar case was found. Duhem and Marfan,⁸ in 1927, reported a case of congenital dislocation of the sacroiliac joints with separation of the pubis. This indicates that congenital separation of the pubic bones must be extremely rare.

CONCLUSIONS

1. Separation of the symphysis pubis following labor occurs more frequently than was formerly believed and is quite rare from all other causes.

2. Very difficult labors and, at times, improper forceps deliveries are the greatest etiological factors in the production of separation of the pubic bones.

3. Roentgen examinations, especially in primiparas, should be made more frequently to discover any disproportion between the presenting part and the pelvic cavity.

4. Separation of as much as 0.9 cm., during or following pregnancy, is considered normal by most observers.

5. Good functional results are usually obtained in the lesser degree separations and marked improvement in practically all cases.

REFERENCES

1. ALLEN, J. M. Report of a case of separation of the pubic symphysis in a forceps delivery and the treatment employed. *Am. J. Obst.*, 1917, 75, 808-809.
2. BEACH, R. M. Traumatic separation of the symphysis pubis. *Am. J. Obst.*, 1917, 75, 203-208.
3. BOORSTEIN, S. W. Separation of the symphysis pubis, with a report of six cases. *Am. J. Obst. & Gynec.*, 1927, 13, 345-351.
4. BUCKLEY, E. W. Report on a case of separation of the symphysis pubis, fracture of the ramus of the pubis and rupture of the bladder. *M. J. Australia*, 1919, 1, 422.
5. CHAMBERLAIN, W. E. The symphysis pubis in the roentgen examination of the sacroiliac joint. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1930, 24, 621-625.
6. DE LEE, J. B. A case of relaxation of the pubic joints during pregnancy. *J. Am. M. Ass.*, 1902, 38, 33-34.
7. DE LEE, J. B. *The Principles and Practice of*

- Obstetrics. W. B. Saunders Co., Philadelphia, 1924.
8. DUHEM, P., and MARFAN. Luxation sacro-iliacque congénitale avec disjonction de la symphyse pubienne. *Bull. Soc. de pédiat. de Par.*, 1927, 25, 179-181.
 9. GOLDTHWAIT, J. E., and OSGOOD, R. B. A consideration of the pelvic articulations from an anatomical, pathological and clinical standpoint. *Boston M. & S. J.*, 1905, 152, 593-601.
 10. HIRST, J. C., and WACHS, CHARLES. Labor injuries to the coccyx and their treatment. *Am. J. Obst. & Gynec.*, 1924, 7, 199-205.
 11. HOLDERMAN, H. H. Fractures of the pelvis with separation of the symphysis pubis. *Pennsylvania M. J.*, 1928, 23, 16-18.
 12. KAYSER. *Arch. f. Gynäk.*, 1903, 70.
 13. KEHRER. Quoted by Boorstein, ref. 3.
 14. KOVEN, M. T. Traumatic separation of the sacroiliac joint and symphysis pubis. *Am. J. Surg.*, 1927, 2, 266.
 15. LYNCH, F. W. Pelvic articulations during pregnancy, labor and puerperium, an x-ray study. *Surg., Gynec. & Obst.*, 1920, 30, 575.
 16. McNAMARA, S. J. Wiring through the obturator foramen for symphysis pubis separation. *Surg. Gynec. & Obst.*, 1916, 23, 625.
 17. MORGAN, W. A. A report of four cases of ruptured pelvis. *Am. J. Obst.*, 1916, 73, 606-613.
 18. SCHAANNING, G. Rupture of the symphysis in pregnancy and labor. *Norsk. Mag. f. Lægevidensk.*, 1924, 85, 727-732.
 19. SPARROW, THOMAS D. Traumatic separation of the symphysis pubis. *J. Am. M. Ass.*, 1930, 94, 27-28.
 20. TULEY, H. E. Rupture of the symphysis pubis in labor. *Am. J. Obst.*, 1913, 68, 852-860.
 21. WILLAN, R. J. Traumatic symphysiotomy. *Surg., Gynec. & Obst.*, 1927, 45, 389-390.
 22. WISHNER, J. G., and MAYER, LEO. Separation of the symphysis pubis. *Surg., Gynec. & Obst.*, 1929, 49, 380-386.



GASTROHEPATIC FISTULA*

CASE REPORT

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SINCE gastrohepatic fistulae are relatively rare, this case seems sufficiently important to warrant reporting. These fistulae are merely pathological curiosities quite impossible to diagnose and are only discovered post mortem.

Gastrohepatic fistulae are usually malignancies which by irritation cause inflammation, resulting in plastic peritonitis with adhesions to the surrounding structures. The thick indurated wall of the carcinomatous stomach produces constant irritation to the liver and causes an ulcer which develops into fistulous communication by ulceration.

CASE REPORT

A. W. D., male, colored; occupation, farmer,

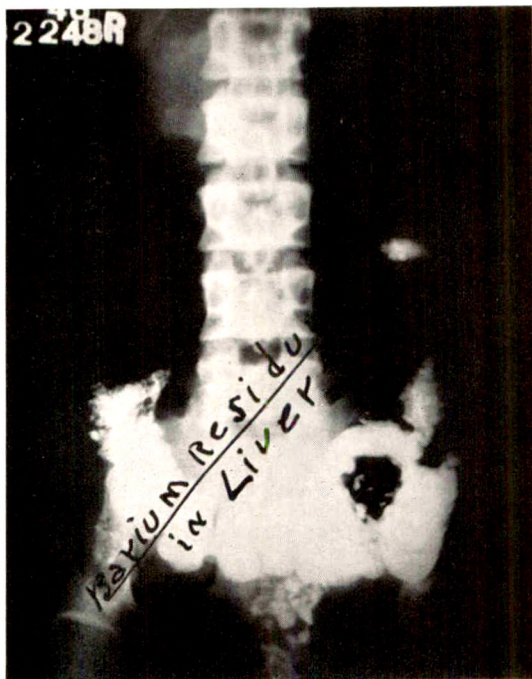


FIG. 1. Roentgenogram shows an island of barium in the liver.

was admitted to Edward Hines Jr. Hospital for treatment of tumor of the abdomen.

Family History. Father dead; cause of death appendectomy. Mother living and in poor health. One brother living and well. Two sisters living and well. No record of tuberculosis, cancer or insanity in the family. Patient is married and has one child.

Personal History. Had measles; does not recall having had any other childhood diseases. Was hospitalized during service for stomach condition. Denies use of drugs, alcohol or tobacco. No operations.

Chief Complaints. Pain in abdomen, worse on left side. Had noticed excessive gas in stomach after eating. During first part of 1930 noticed shortness of breath. Tires easily. For the past ten months has had pain in left side of abdomen. Swelling of the feet and legs. Loss of weight. Has been unable to work on account of extreme weakness.

Physical Examination. Poorly developed male; appears chronically ill. Skin, eyes, mouth, chest, heart and pupils negative. A mass was felt in the pit below the border of the ribs on the left side, three fingers breadth below and extending up under the costal margin, somewhat tender.

Special Surgical Consultation. Patient presented a history of loss of weight, having lost 20 pounds since 1930. He appeared cachectic and had a large solid mass immediately over the stomach.

Laboratory Findings. Urinalysis negative. Blood Wassermann and Kahn negative. Fractional stomach contents: Occult blood. Feces brown in color; no parasites or ova found; consistency mushy. Occult blood positive. Protozoa none. Mucus none.

Roentgen Examination of Chest and Heart. Stereoscopic roentgen examination of the chest revealed evidence of an old fibrous adhesion at both bases. The bony framework of the thoracic cage exhibited no anatomical or pathological

* Published by authority of J. G. Donnelly, Acting Medical Director, United States Veterans Administration.

variation from the normal. Cardiac image at 6-foot distance was of normal size, shape and position, revealing no bulging, displacement or other roentgen evidence of organic pathology. Lung fields were radiant throughout all lobes, displaying no demonstrable evidence of intrapulmonary pathology.

Roentgen Examination of Gastrointestinal Tract. Roentgenoscopic examination revealed the opaque media passing through the esophagus without undue hesitation. Stomach showed a large filling defect involving the pars media and lesser curvature side of the stomach; walls were inflexible. No peristaltic waves were seen. The duodenal cap was not visualized and there appeared to be considerable obstruction at the pylorus.

Roentgenographic examination confirmed the roentgenoscopic findings, showing on the immediate films a large filling defect of the pars media. An island of barium was in the region of the pars media at forty-eight hours (Fig. 1). Gallbladder was not visualized.

Autopsy. (Performed by Dr. W. L. McNamara, assistant pathologist.) Body was that of a fairly well-developed, markedly emaciated male. Skin was icteric, as were the sclerae and mucous membranes. Abdomen was distended. There was a patent gastroenterostomy. No glandular enlargement. Pupils equal.

Peritoneal Cavity. No adhesions to the chest plate. Both lungs inflated; about 500 c.c. of fluid at each base. Pericardial sac occupied a normal position and contained 50 c.c. of clear fluid. Pericardium smooth.

Heart. Heart weighed 320 grams; muscle pale and very poor in consistency. Aortic and mitral valves held water. No atheromatous change in the aorta. Coronary vessels clear.

Liver. Liver was enormous; surface nodular,

with large grayish-white tumor metastases; left lobe was enlarged to a greater size than the right. Stomach was rotated so that the anterior surface was in contact with the under surface of the left lobe of the liver. A large fungating

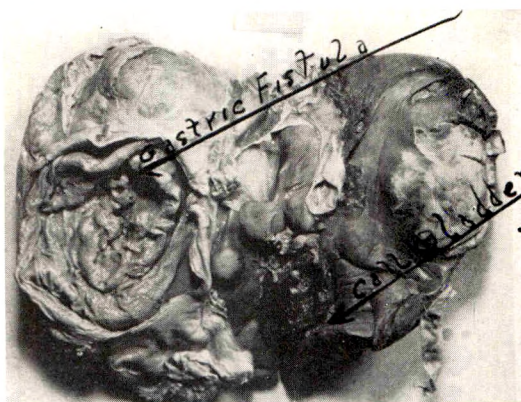


FIG. 2. Photograph of autopsy specimen, showing carcinoma of the stomach, involvement of the liver and a gastrohepatic fistula.

tumor mass which measured 6 cm. in diameter involved the anterior wall of the stomach near the greater curvature. This was in direct contact with the under surface of the liver and dense adhesions bound the two. Tumor mass had invaded the liver diffusely. There was much digestion of tumor tissue and the digested cavity was about the size of a large grapefruit (Fig. 2). A small area had broken through and was covered with omentum.

Gallbladder. Gallbladder was distended due to pressure on the cystic duct. Wall was thin and there were no stones.

Anatomical Diagnosis. Adenocarcinoma of stomach with extension to the liver.

Roentgen Diagnosis. Carcinoma of stomach.



LATE RESULTS FROM COMBINED ELECTRO-COAGULATION AND IRRADIATION OF SUPERFICIAL CANCERS

By H. H. HAZEN, M.D.

WASHINGTON, D.C.

THE well-deserved popularity of electrocoagulation in America is due to the splendid pioneer work of Clark,³ Pfahler,⁹ Wyeth,¹¹ and a few others. My own work with this form of treatment was begun some ten years ago, and for the past six years has been the method of choice. Electrocoagulation presents certain great advantages: (1) Examination of tissue is possible in all cases; (2) the removal of the growth is prompt; (3) it can be used in growths that have resisted irradiation, or that are situated in scar tissue or cartilage; (4) it can be used in areas that are difficult of access to either the knife or irradiation; (5) the permanent results are superior to those obtained by any other method. By the proper use of local anesthesia the operative procedures are practically painless; there is almost no after pain and the scarring is usually very slight as the wound granulates up from the bottom. The chief disadvantage is that the wound heals slowly; five weeks in the case of small growths, and seven to eight weeks in large growths being the usual time. During this period social activities may require a simple dressing.

The technique employed has been the usual one in all details; all operations have been done under a local anesthetic; the growth circled with the cutting current and tissue removed for examination, then deep coagulation, and lastly the thorough undercutting of the skin in all directions. The roentgen or radium treatments were given as soon as the wound was healed, and consisted of $2\frac{1}{2}$ to 4 S.E.D. In some instances a second treatment was employed. Radium needles were used externally. In no instance was there irradiation of the draining lymph nodes, although the whole field for an area of at least 1 or 2 inches

beyond the edges of the scar was irradiated in all cases of squamous cell cancer.

In this study only the cases which have been personally checked are reported; in other words, they represent consecutive, unselected cases from private practice.

TABLE I

Total cases followed.....	93
Males.....	54
Females.....	39
Squamous cell tumors, patients..12	growths...12
Basal cell tumors, patients.....81	growths...87
Patients with multiple growths... 6	

In addition there was one man who had 20 basal cell cancers of the eczematoid, or psoriaform, type⁵ removed with cure for two years. This tumor should be distinguished from the Bowen type,² or Paget's disease,⁸ both of which are believed to be intradermal tumors probably springing from glandular structure.⁴

The location of the prickle cell cancers is shown in Table II.

TABLE II

Tongue.....	1
Lip.....	7
Nose.....	1
Cheek.....	3

The location of the basal cell growths is shown in Table III.

With one exception the squamous cell cancers were of less than one year's duration and none were over an inch in diameter. The exception was in the case of an elderly man who had a growth of nearly 3 inches in diameter situated upon the right cheek and secondary to lupus erythematosus. This patient was well for two years when he died from intercurrent disease.

TABLE III

Scalp.....	2
Forehead.....	2
Temples.....	5
Cheeks.....	28
Nose and naso-facial folds.....	24
Ears.....	6
Lips.....	1
Inner canthi.....	2
Outer canthi.....	3
Eyelids.....	3
Chin.....	1
Neck.....	5
Trunk.....	2
Hands.....	2

The size of the basal cell lesions is given in Table IV.

TABLE IV

Under $\frac{1}{2}$ inch.....	22
$\frac{1}{2}$ to 1 inch.....	54
Over 1 inch.....	11

The extent of the involvement, or the occurrence in scar tissue, whether produced by trauma, disease, irritation, or operation is shown in Table V.

TABLE V

Bone involvement.....	1
Cartilage involvement.....	9
Scar tissue.....	8

In the course of 150 operations for malignancy there has been only one patient who complained of the scar, and in only one instance was there a serious postoperative complication. In the last mentioned instance a fatal pulmonary embolism developed eight days after the removal of a vulvar neoplasm. A review of the literature reveals the fact that such a complication is exceedingly rare. In 3 instances there has been annoying, and in one other serious, hemorrhage in from three to six days after operation. In all instances operative work had been carried down to the periosteum. It is possible that by using a weaker current, especially toward the conclusion of the operation, the liability of such accidents can be materially lessened.

The results in prickle cell cancer are shown in Table VI.

TABLE VI

Failure.....	3
Cure, one year.....	1
Cure, two years.....	4
Cure, three years or more.....	4

The results in basal cell cancer are shown in Table VII.

TABLE VII

Failure.....	2
Cure, one year.....	7
Cure, two years.....	18
Cure, three years.....	23
Cure, four years.....	15
Cure, five years or more.....	16

The percentage of cures in prickle cell cancer was 75, and in unselected basal cell growths 97.5. There is an appalling paucity of reports of late results in superficial cancer but the general impression is that the results are better than by any other method. Stevens¹⁰ reports 100 per cent of cures. Andrews¹ gives an excellent bibliography. A comparison of the results obtained in basal cell cancer by endothermy and various other procedures⁵ is shown in Table VIII; the figures represent the percentage of cures.

TABLE VIII

Selected Cases	Unselected Cases	
	per cent	per cent
Surgery.....	93	86
Roentgen rays.....	93	84
Radium.....	93	84?
Curette and caustic.....	90?	?
Endothermy.....	97.5	97.5

The reports of the results obtained by various therapeutic measures in squamous cell cancer are widely divergent. This is because it is totally unfair to compare the results obtained by an excellent surgeon with those of an inexperienced roentgenologist, and vice versa. Once again the reports of experienced and reliable men would seem to show that combined endothermy and radiotherapy is by far the best method of treatment.

There are many roentgenologists, of whom Martin⁷ is a notable example, who

believe in caustic doses of irradiation. There is no doubt that a high percentage of malignancies of all types can be cured by doses of roentgen rays sufficient to cause a local necrosis. To me this does not appear as good a method as endothermy, for which there are several reasons: First, if filtered radiation is used the action upon deeper tissues will probably be marked. Several cases of irreparable damage to teeth and gums have been seen as a result of this method of treatment. Second, there is usually more after-pain as the result thereof. Third, the question arises as to how heavily an area about 1 inch beyond the tumor proper should be irradiated. Certainly this whole area should not be treated with a dose sufficient to cause a necrosis and to treat the edges properly may be a good deal of a problem. Fourth, tissue is not always obtainable for biopsy unless a preliminary curettage be done. Fifth, a knowledge of the extent of the lesion is much better learned from removal of the growth, such as is possible with the cutting knife, than from mere surface inspection and palpation. Sixth, healing is apt to be slower than with endothermy.

A study of failures is always of interest. The first instance was in a squamous cell cancer of the upper lip originating in a chronic radiodermatitis and where the pa-

tient positively refused an operation of necessary extent. Local recurrence occurred in one year. A second instance was where a cancer of the cheek had recently received a great amount of irradiation. In the third patient a rapidly growing prickle cell growth, of the most malignant type, on the bridge of the nose remained well for two years, but after ten months there was extension to the cervical lymphatics. The two cases of failure in basal cell cancer were in rather extensive growths of the ear. In the first patient endothermy was not extended into the cartilage, and in the second case the operative field was not sufficiently wide.

CONCLUSIONS

Combined electrocoagulation and irradiation is the most successful method of combating superficial malignancy. Except where the cartilage or bone is deeply invaded it should be successful in all cases of basal cell cancer, and probably in about 75 per cent of the squamous cell growths of lips and skin. Squamous cell growths in areas of radiodermatitis or scar tissue are especially difficult to manage.

The cosmetic results are excellent; the only disadvantages are the slow healing and the tendency to hemorrhage where the periosteum is treated.

REFERENCES

1. ANDREWS, GEORGE C. Diseases of the Skin. W. B. Saunders, Philadelphia, 1930, pp. 253-254; 951.
2. BOWEN, J. T. Precancerous dermatoses; a study of two cases of chronic atypical epithelial proliferation. *J. Cutan. Dis.*, 1912, 30, 241-255.
3. CLARK, W. L. Cancer. *J. Am. M. Ass.*, 1918, 71, 1365.
4. FRASER, J. F. Bowen's disease and Paget's disease of the nipple; their relation to dyskeratosis. *Arch. Dermat. & Syph.*, 1928, 18, 809-828.
5. HAZEN, H. H., and WHITMORE, E. R. The end results in roentgen-ray treatment of cutaneous cancer. *Am. J. ROENTGENOL. & RAD. THERAPY* 1925, 13, 144-157.
6. KETRON, L. W. Superficial epitheliomas. *J. Cutan. Dis.*, 1919, 37, 22.
7. MARTIN, C. L. Squamous cell carcinoma of the skin. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 28, 728-737.
8. PAGET, JAMES. On disease of the mammary areola preceding cancer of the mammary gland. *St. Barth. Hosp. Rep.*, 1874, 10, 87-89.
9. PFAHLER, G. E. Cancer of the lip. *Arch. Dermat. & Syph.*, 1922, 6, 428-433.
10. STEVENS, J. T. Statistics and technique in the treatment of superficial malignancy with radium, roentgen rays, and electrothermic coagulation. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1924, 11, 241-246.
11. WYETH, G. A. (Discussion of paper by E. S. Lain on "Treatment of cancer of the lip by radiation.") *Arch. Dermat. & Syph.*, 1922, 6, 443.

AN EPIPHYSEAL CHART*

By PAUL C. HODGES, Ph.D., M.D.
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MOST morphological questions in human embryology or gross anatomy may be answered readily by reference to standard atlases and texts, but in the case of the non-adult skeleton much disagreement exists. The situation is explained in part by the fact that it is extremely difficult to obtain children's bodies for dissection. This limitation has not been particularly serious as far as the muscles, blood vessels, etc., are concerned and of course autopsies provide adequate material for the study of visceral development. It has, however, greatly hampered study of the skeleton during an important stage of its development.

For many years roentgen rays have been employed to some extent in anatomical investigation, but for the most part anatomists have ignored the roentgen method or even decried its use.¹⁴ Recently there has been general recognition that the roentgen rays constitute a dependable tool by means of which the anatomist can acquire an unlimited supply of material at any desired age.^{6,10,12} However, the addition of roentgenologic data has introduced new problems because such terms as "appearance of ossification" and "fusion of epiphyses" which have definite significance to the anatomist conducting a gross dissection must be reinterpreted if one is to use them in describing skeletal roentgenograms. The point is illustrated by the publications of Stevenson¹⁴ and Paterson.⁹ The former reporting on physical examination of dried skeletons gives ages of epiphyseal fusion somewhat greater than most other workers. The latter studying roentgenograms of the living finds epiphyses fused much earlier. Almost certainly these discrepancies represent lack of uniformity in terms and criteria rather than true biological difference. Certain ossification centers may escape detec-

tion in conventional roentgenograms but be perfectly obvious at dissection. Paterson has pointed out Cohn's³ error in the case of the greater tuberosity of the humerus but agrees with him that the lesser tuberosity does not appear as a separate center*.

The chart presented here is designed for ready reference to contemporary information on most of the phases of skeletal development in the human trunk and extremities of the sort likely to come up for consideration during the routine reporting of clinical roentgenograms. As far as possible, it has been constructed on data from published roentgenographic studies of the living^{2,6,8,9,12,13} but, in order to accomplish some degree of completeness, it has been necessary to draw as well on the published results of dissecting room studies, roentgenograms of dead material and the study of cleared specimens.^{7,14}

SPINE

In the case of the primary vertebral centers, the chart accomplishes conventionalization without serious distortion of Bardeen's classical publications.¹ Hanson's articles supply data for the late epiphyses.⁴ Roederer and Lagrot's¹¹ data on fusion of laminae are controversial and may not stand the test of time. They have been employed in the chart because they are based on studies of the living and, in a general way, seem to agree with casual uncontrolled observations in this laboratory.

NUTRIENT CANALS

Harman,⁵ working in Sullivan's labora-

* In spite of this, it seems well to include the lesser tuberosity in the chart on the assumption that dissecting room reports are dependable and that special tangential views of the anterior surface of the humerus in children of about three years will probably show this center in roentgenograms as well.

* From the Division of Roentgenology, Department of Medicine, University of Chicago.

tory at the University of Wisconsin, has shown that there is much variation in the number, location, and direction of the nutrient canals of the femur. Presumably the same is true of other long bones, but if one keeps in mind the possibility of variation, it is probably safe and of some value to recognize the existence of a conventional pattern. According to this convention, the canal, in its passage from the cortex to the medulla, is directed toward the end of a long bone at which the epiphysis appears latest and fuses earliest or, in those bones equip-

ped with only one epiphysis, toward the end lacking an epiphysis.

VARIATIONS

Only the most common of the congenital anomalies are shown in the column at the left, but it is planned to publish later Part II dealing in some detail with anomalies of trunk and extremities, and Part III showing the normal and anomalous development of the skull.

The method of charting is a modification of that used in the textbook of Schinz, Baensch and Friedl.¹³

REFERENCES

1. BARDEEN, C. R. *Manual of Human Embryology*. Keibel and Mall, Editors. J. B. Lippincott, Philadelphia, 1910, pp. 292-453.
2. CAMP, J. D., and CILLEY, E. I. L. Diagrammatic chart showing time of appearance of the various centers of ossification and period of union. *Am. J. Roentgenol. & Rad. Therapy*, 1931, 26, 905.
3. COHN, ISADORE. *Normal Bones and Joints*. *Annals of Roentgenology*, Vol. IV. Paul B. Hoeber, New York, 1924.
4. HANSON, ROBERT. Some anomalies, deformities and diseased conditions of the vertebrae during their different stages of development, elucidated by anatomical and radiological findings. *Acta chir. Scandinav.*, 1926, 60, 309-368.
5. HARMAN, HUBERT F. The Position of the Nutrient Foramen in the Os Femora. Unpublished thesis from the Department of Anatomy. University of Wisconsin.
6. VON HASSELWANDER, A. Die Entwicklung des Skelets. *Handbuch der Anatomie des Kindes*. J. F. Bergmann, München, 1931, pp. 403-589.
7. JAMIESON, E. B. Chapter on Osteology, Cunningham's Textbook of Anatomy. Fifth Edition. William Wood & Co., New York, 1928, p. 90.
8. KÖHLER, ALBAN. *Röntgenology: The Borderlands of the Normal and Early Pathological in the Skiagram*. Translated into English from the Fifth German Edition by Arthur Turnbull. William Wood & Co., New York, 1928.
9. PATERSON, R. S. A radiological investigation of the epiphyses of the long bones. *J. Anat.*, 1929, 64, 28-46.
10. PRYOR, J. W. Differences in the time of development of centers of ossification in the male and female skeleton. *Anat. Rec.*, 1923, 25, 252-273.
11. ROEDERER, C., and LAGROT, F. Le diagnostic radiologique du spina bifida occulta lumbosacrée. *J. de radiol. et d'électrol.*, 1926, 10, 255-261.
12. RUCKENSTEINER, E. Die normale Entwicklung des Knochensystems im Röntgenbild. Georg Thieme, Leipzig, 1931.
13. SCHINZ, H. R., BAENSCH, W., and FRIEDL, E. *Lehrbuch der Röntgendiagnostik*. Third edition. Georg Thieme, Leipzig, 1932.
14. STEVENSON, PAUL H. Age order of epiphyseal union in man. *Am. J. Phys. Anthropol.*, 1924, 7, 53.



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EDITORIAL

MARCH FOOT OR PIED FORCÉ

ROENTGENOLOGISTS should be interested in the condition known as "march foot" or "pied forcé" for two reasons: first, because it was one of the first conditions to be investigated by the roentgen ray, and second, because of the possibility of its confusion with a malignant process. The first roentgen-ray observations were made by Stechow of the Prussian Guard, at Madrid, in 1897. He discussed fracture of the metatarsals as the cause of swollen feet in soldiers, having seen thirty-six cases. The condition was first described in 1855 by Breithaupt who observed cases of persistently edematous and painful feet occurring in soldiers. He called it "Fussgeschwulst," that is, a traumatic inflammation of the tendon sheaths. It was later described by Chapotot and Boisson in an article entitled "Le Pied forcé." Reports of this condition have appeared from time to time in the foreign literature but comparatively little has been published in American journals.

March foot is a subacute, painful affection of the forepart of the foot, occurring chiefly about the shafts of the metatarsals and surrounding soft parts. It has an insidious development with slowly increasing pain, which first arises after prolonged excessive effort, later after ordinary exercises, and ultimately may become continuous, often incapacitating the patient. Since the introduction of motor transports for the rapid movement of troops the condition has become much rarer, though it still occurs among soldiers. It is also found among the civil population in those engaged in similar heavy occupations, such as pedlars, and it may occur in those engaged in sports, such as golfing; cases have been found in women engaged in strenuous

standing and weight-carrying work, for example, waitresses, shop assistants, and nurses.

Clinically the condition is characterized by swelling which appears on the dorsum of the foot, usually in the region of the shafts of the second and third metatarsals invading the soft tissues and bone. The skin may be slightly reddened and definitely tender to palpation. This later may be accompanied by bony swelling of the shaft of one of the metatarsals, usually the second or third. The swelling of the shaft of the metatarsal is due to the presence of callus which has arisen around an oblique or V-shaped fracture of the shaft of the metatarsal at the junction of the middle and distal thirds, the fracture occurring there because it is slightly weakened due to the entry of the nutrient vessels into the metatarsal shafts at that point.

Dodd¹ has recently called attention to the condition and he believes that "March Foot is a complication of subacute flat foot occurring in architecturally weak feet. In these muscular spasm and exhaustion alternate, and as the latter supervenes, the stout ligaments of the foot are gradually stretched, and direct trauma to the bony skeleton of the foot occurs. These undamped shocks will produce effects in the weakest bones first, and the slender, resilient metatarsals fall into this category.

"As the flat-foot develops, the feet take up the usual flat-foot position, pointing outwards, instead of approximately straight forwards. Thus the body weight is no longer carried through a line passing between the first and second metatarsals, parallel to their shafts, and distributed

¹ Dodd, Harold. Pied forcé or march foot. *Brit. J. Surg.* July, 1933, 21, 131-144.

squarely on to the five heads of the metatarsals, but falls largely in an oblique direction on the inside of the foot, i.e., on the first most . . . , the second next, then the third, and to a lesser degree on the fourth and fifth. If the foot is architecturally weak, as appears to be frequently the case in March Foot, then a hypermobile first metatarsal will roll away from this weight, and as a congenitally short metatarsal cannot reach to the ground to carry the strain, then the weight must pass primarily on to the second metatarsal and in decreasing amounts through the third, fourth, and fifth." The first metatarsal is a much larger and stronger bone than either the second or third so that structural changes resulting from abnormal stress will be shown much earlier in the second and third than in the first metatarsal. Extra stress does, as Dodd says, occur on the first metatarsal, as is shown by the thickening and increased density of its outer border, this sign being present in all the fourteen cases which he studied roentgenographically. In flat-foot, after the first metatarsal, the brunt of the misplaced weight falls on the second metatarsal and when the supporting power of the muscles and ligaments of the calf and foot is exhausted, the second metatarsal would be the first to "crack" because it has a much more slender bony structure than the first metatarsal. Dodd concludes that march foot is probably an auto-traumatic complication of subacute flat-foot in an architecturally weak foot, rather than a separate clinical entity.

The roentgen findings are of considerable importance. There is usually bony swelling of somewhat fluffy, bulbous outline, due to callus, at the junction of the distal and middle thirds of either, and occasionally even of both, of the shafts of the second or third metatarsals, much less often of the fourth or fifth, and extremely rarely of the first. The bony proliferation occurs around a partial or complete fracture, usually without displacement. In the early stages there is increased density of the shafts of the metatarsals where the interosseous muscles arise, namely, the second, third, fourth, and inner border of the fifth. The outer border of the first metatarsal shaft is also dense, but the change is most marked in the second or third metatarsal shafts. Other bulbous swellings may occur about the shafts of the proximal phalanges of the second, third and fourth toes. These bulbous swellings are probably due to localized periostitis at the site of attachment of the flexor tendon sheaths. The bony proliferations about the shafts of the metatarsals may be so dense at the time the patient is roentgenographed as to completely obscure the subperiosteal type fracture and, owing to the bony reaction to the trauma, namely, an excessive periostitis, the condition is frequently mistaken for sarcoma of the shaft of the metatarsal or for syphilitic periostitis. It is imperative that the condition known as march foot be thought of as a possibility in the differential diagnosis as otherwise the patient may be subjected to an unwarranted operation or amputation.



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Annual meeting: 1934, to be announced.

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Meets third Tuesday in each month from September to May.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY

Secretary, Dr. R. T. Taylor, Los Angeles, Calif.

Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.

Annual meeting: Richmond, Va., November, 1933.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N. Y.

Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.

Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. R. G. Willy, 1138 N. Leavitt.

Meets second Thursday of each month October to May inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. Otto Glasser, Cleveland Clinic.

Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital.

Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.

Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill.

Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. N. Collins, Indianapolis, Ind.

Annual meeting each February 22 in Indianapolis.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Detroit, Mich., February, 1934.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.

Meets first Friday in October, December, February and April. Place of meeting designated by the president.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.

Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.

Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY

Secretary, Dr. Major Fleming, Rocky Mount, N.C.

Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. H. S. Bull, 604 Masonic Temple, Auburn, N. Y.

Three meetings a year—January, May and November.

PACIFIC ROENTGEN CLUB

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif.

Meets annually, during meeting of California Medical Association

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Reiley, Clearfield, Penna.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. Karl Kornblum, Graduate Hospital.

Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. W. W. Fray, Strong Memorial Hospital.

Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB

Secretary, Dr. W. K. Mueller, University Club Bldg.

Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston.

*Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Meets at time and place of South Carolina State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY

Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.

Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

UNIVERSITY OF WISCONSIN ROENTGEN CLUB

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis.

Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 P. M.

VIRGINIA ROENTGEN RAY CLUB

Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.

Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA

Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba.
Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.

Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

INDIAN RADIOLOGICAL ASSOCIATION

Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta.

Meets annually in January, and at such places and times as the Council may appoint.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY

Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgian).

Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE

Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.

Secretary for German language, Dr. Scheurer, Molzgasse, Biel.

Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE

Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA

Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)

Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.

Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY

Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETÀ ITALIANA RADIOLOGIA MEDICA

Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banul Maracine 30, Bucarest, Rumania.

Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson.

Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin.

Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY.

Secretaries, Drs. L. L. Holst, A. W. Ssamygina and S. T. Konobejevsky.

Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. B. Krynski, 11 Zielna St.

Meets once a month except in the summer time.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN

Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY

Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK

Secretary, Dr. H. Scheuermann, Copenhagen.

Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND

Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY

Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION

c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY

Director, Dr. Prof. Taiga Saito, Ogawagike, Kyoto, Japan. Meets bi-monthly on third Sunday.

JAPANESE ROENTGEN SOCIETIES AND ROENTGENOLOGICAL LITERATURE

EDITOR'S NOTE: The following interesting letter was received by Dr. Paul C. Hodges of the University of Chicago and it has been forwarded to the Journal with the thought that the information it contained concerning Japanese roentgen societies and literature would be of interest to the readers of the Journal:

MY DEAR DR. HODGES:

I want to acknowledge your letter, dated April 5, which reached me unusually late for some unknown reasons; this may partly explain my delay in answering your letter.

Although we have many articles published in many different magazines about Roentgenology now-a-days, most of them are only written in the Japanese languages and only few have foreign abstracts; for example, the official Journal for the Nippon Roentgen Society has no foreign abstracts.

In this circumstance I feel it exceedingly inconvenient to show our works in Japan to the foreign colleagues at the present time. The "Literaturregister" is the book which has been published by Dr. K. Fujinami and his associates, Keio University, Tokyo, and this contains all the names of literatures about Roentgenology and Physical Therapy in Japan 1912-1929, translated into German language. I am sending this to you and I hope it may help you to give some idea of our works in Japan in Roentgenology.

The Nippon Society has been established in 1922 and the first official Journal of the society was published in July of this year. Since then the Journal of the Nippon Roentgen Society is published six times a year in every month. Unfortunately, the articles are written only in the Japanese language without foreign abstract at the present time. The Nippon Roentgen Society has a local branch in main cities in Japan

and every branch holds a scientific roentgen meeting regularly once every month. In April every year the Nippon Roentgen Society holds its annual general meeting cooperated with the other branches of Medicine at one of the large cities which have also their meetings at the same place respectively. The Nippon Roentgen Society has about 700 regular members at present time and the president-elect of this year is Professor Kaichiro Manabe, who is the director of the Physical therapy Department of the Tokyo Imperial University. Besides the official Journal of the Nippon Roentgen Society, we have two private magazines for Roentgenology and Physical therapy. One is the "Igaku-shimpo" and the other is the "Jitsusen-Irigaku." The former is published every month and edited by Dr. Juichi Ogawa, Kobe, and the latter is edited and supervised by Professor K. Fujinami, Keio University, Tokyo and published every other month, six times a year.

The "Sakura" film has made its first appearance as the Japanese-made film very recently and is on sale from the beginning of May of this year after repeated experimentations and observations of many Roentgenologists who all agree "Sakura" films are available as X-ray diagnostic films and the slight inferiority of its quality to the imported films is to be compensated by the prices which are almost 25% cheaper than the foreign films.

Our works in St. Luke's hospital are recently very much enlarged and we have about 60-70 patients daily in our Department of Roentgenology and Physical Therapy, keeping the staff busy.

The St. Luke's Medical center will have its dedication ceremony on the fourth and fifth of July for the New Building of Nursing Dormitory and part of the hospital building. The buildings for the out-patient and Roentgenology are not built yet, so that we don't know whether we are moving to the new building or not.

Yours Sincerely,

TAKEO INOUE



DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., 105 Rutledge Ave., Charleston, S. C.

A COMBINED SINUS AND MASTOID HEAD REST

By RALPH E. HERENDEEN, M.D., and FRANK HUBER, M.D.
NEW YORK CITY

THIS apparatus, primarily for the roentgenography of the nasal accessory sinuses and mastoids, is based on the principle of adjusting the head rest for the different positions of the patient's head without moving or changing the angle of the tube.

The device is essentially a tunnel for an 8" X 10" cassette which can be tilted at any desired angle in one plane with or without a simultaneous 15° tilt to either side. By this means the various postures used in sinus and mastoid roentgenography may be obtained with a constantly vertical central ray. A transparent top of some celluloid material may be optionally incorporated in the tunnel supplanting the opaque top and, with the employment of a mirror below, aids somewhat in positioning the head, notably in the nose-forehead sinus view and in the mastoid view, but this innova-

secondary radiation. For the sinus series the diameter of the orifice in the mask is from 5 to 6 inches and for the mastoid 4½ inches. The cone or cylinder used must necessarily produce a beam of slightly greater diameter.

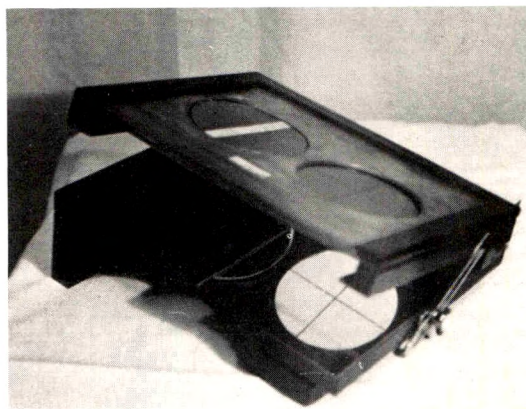


FIG. 2. Oblique view of head rest with 15° tilt in two planes for examination of right mastoid. Note reflections of centering lines in mirror below.

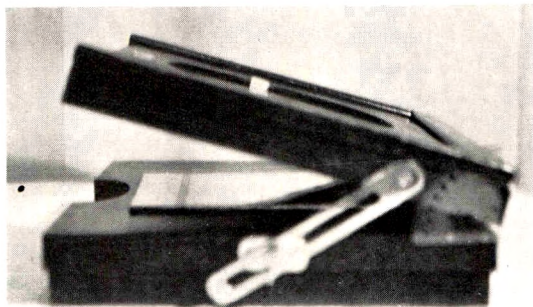


FIG. 1. Lateral view of head rest with tunnel tilted at 20°. (Usual angle for nose-forehead sinus.)

tion, originally reported by Petersen,¹ is by no means indispensable. Metal masks are placed over the tunnel top to block out

The actual procedure of examination is to seat the patient before a small table on which the head rest is placed. The central ray of the vertical roentgen-ray beam is made to pass through the center of the circle on the tunnel top. Technical factors are those of non-Potter-Bucky head roentgenography. Immobilization or rather steadying of the head either by lateral clamps or a weighted canvas band is sometimes desirable. This is preferable to raising or lowering the tube for direct immobilization of the head with the cone or cylinder.

The sinus views are taken in the following sequence:

1. Lateral (right or left)—center external

¹ Petersen, B. W. A simple quick centering apparatus for stereoscopic mastoid roentgenography. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 28, 561-562.

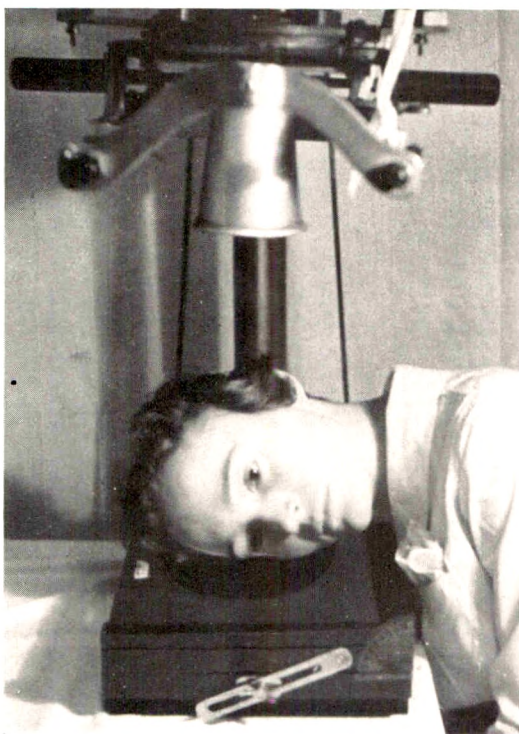


FIG. 3. Set-up for right lateral position.

canthus, head true lateral, tunnel horizontal.

2. Nose-chin (Waters)—center tip of nose, elevated $\frac{1}{2}$ inch by small cork block, tunnel horizontal.

3. Nose-forehead—center root of nose (glabella), using mirror before inserting cassette, tunnel tilted 12 to 20°, usually 17°. This latitude of inclination varies directly with the size of the nose and is consequently smaller for children.

4. Vertico-mental (Hirtz)—chin extended to upper edge of orifice and mask, head hyper-extended, center midway between chin and larynx, increase the tunnel angle until the central ray passes through the sella point (1 inch in front and above the external auditory meatus). By this maneuver the base line of the skull approaches the horizontal. It is frequently necessary to tilt the tube slightly; the shorter the neck and more receding the jaw, the greater the angle to which the tunnel must be raised.

Similarly in investigation of the mas-



FIG. 4. Set-up for nose-chin (Waters) sinus position.



FIG. 5. Set-up for nose-forehead sinus position.



FIG. 6. Set-up for vertico-mental (Hirtz) sinus position.



FIG. 7. Set-up for oblique or Rhese position for optic foramen.

toids the patient is seated, although for children the reclining position may be used. A 15° double tilt of the tunnel is obtained and the tube centered to either right or left opening in the mask. The head is placed so that its median sagittal plane is parallel to the plane of the tunnel, the chin always pointing down and out. The external auditory meatus is centered using the mirror. Right and left sides are taken. Stereoscopic views are made by shifting the tube towards the occiput.

In addition to these routine views the apparatus is well adapted to several accessory views. The optic foramen and the relation of the canal for the optic nerve to the posterior ethmoidal and sphenoidal cells is well shown by the Rhese or oblique position in which the orbit is centered and the head rests on three points: the outer portion of the eyebrow, the cheek bone, and the side of the nose. The tunnel is horizontal. The Arcelin position for the petrous tip and an

oblique view of the mastoid utilizes the same set-up except that the center point is midway between the external canthus and mastoid tip. Stereoscopic views may be made in both of these positions by employing the same technique as in the mastoid stereo. It is possible to include both these views in a single exposure by using the mask with the large opening and the technique for the optic foramen.

The tunnel also lends itself to plain or stereoscopic lateral views of the jaw by elevating one end piece. Here, however, the tube must be angled as for the usual jaw view.

Adoption of the principle set forth by Loughery and Stecher² supplies a method of obtaining the four sinus views or stereoscopic views of both mastoids on a single $10" \times 12"$ cassette. This is accomplished by

² Loughery, T. P., and Stecher, W. R. An improved stereoscopic mastoid examination. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1933, 29, 112-115.

means of a suitable mask and by insertion of the cassette in its long axis.

By the use of this combined sinus and mastoid head rest the technique of examination is simplified as much as the requirements of multiple and accurate positioning

allow. Standardization of views is a distinct aid in interpretation. Results are reproducible.

The apparatus is suitable for all the views necessary in a complete investigation of the sinuses and mastoids, and supplants more complicated and expensive mechanisms.



FIG. 8. Set-up for right mastoid position. Note reflection of field in mirror.

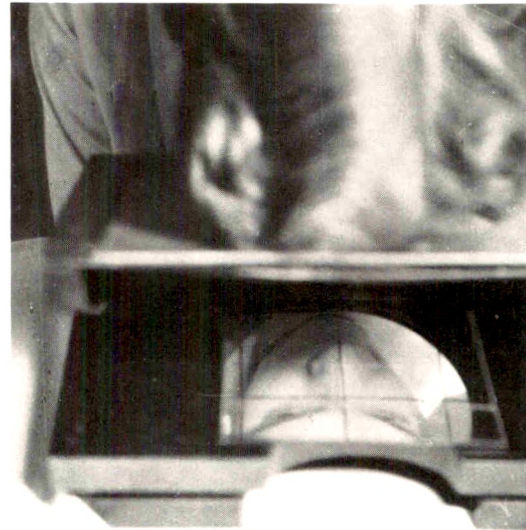


FIG. 9. Set-up for nose-forehead in illustrating centering of head in mirror.



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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

SKELETAL SYSTEM

- FREJKA, BEDRICH. Kyphosis adolescentium. *J. Bone & Joint Surg.*, July, 1932, 14, 545-554.

Kyphosis adolescentium was first described by Scheuermann, 1921. Mau, Sorrel and Delahaye, Buchman, and others, attribute the disease to the changes in the spinal epiphyses and consider this condition to be definitely similar to Legg-Perthes-Calvé's disease of the hip joint. The author states, however, that this opinion does not tally with the fact that this affection is not limited to the period from twelve to twenty-five years of age, for it is frequently observed in

the first decade of life, before the epiphyses are developed.

Mau, quoted by the author, distinguishes three stages in the development of kyphosis adolescentium: (1) the stage of onset, (2) the stage of deformity which exists usually for a long time, two or more years with gradual increase of the condition and (3) the stage of reparation. Mau emphasizes the fact that the latter stage depends upon the period of growth and the roentgen ray shows that the irregular, toothed, indistinct outline of the vertebral bodies again becomes clear, the atrophy disappears, the anterior edges of the vertebral bodies develop areas with spurs which change in severe cases, with the result that the anterior part of

the body becomes saddle-shaped. Mau explains this condition as originating in the overloading of the spine at the time the epiphyses are developing. The blood vessels nourishing the epiphyses become injured and finally obliterated which results in a necrosis of the epiphyses.

Scheuermann and Mau call the small toothed projections at the upper and lower anterior borders of the vertebral bodies the special epiphyses and Mau suggests in detail an analogy to the epiphyses of animals. However, Schmorl does not regard these as typical epiphyses, their function being to join the vertebral body firmly to the vertebral plate. This union is so firm that occasionally, by trauma to the epiphysis, a triangular section is torn from the body of the vertebra.

Schmorl's theory of the cause of kyphosis adolescentium is that of a disturbance in the development of the intervertebral discs. In the roentgenogram, rounded or toothed projections of the intervertebral plate into the bone tissue of the body can be seen. With the overloading due to trauma, the tissue of the nucleus pulposus presses into the openings of the body, causing an atrophy of the bone which often extends into the spongiosa. Further progress is stopped by reactive changes which result in a sclerotic condensation and a walling off of the "knot" or "whorl." These small furrows of bone, Schmorl considers as typical of adolescent kyphosis.

Frejka, in spite of the authority of Schmorl, does not consider that this thoroughly explains all the phenomena which accompany kyphosis adolescentium. It fails to explain the blurred outline of the anterior part of the bodies of the vertebrae in the early stages of the affection, and also does not explain the typical cycle of two or three years as described by Mau. He reports 3 cases, all of which showed evidence of tuberculous involvement of the spine. In the first patient the illness began at the eighth to the tenth year, in the second the symptoms were first noticed between the fourth and sixth years and in the third, at twenty-three years of age. The onset of the disease in these cases has no relation to the development of the vertebral epiphyses. In the first case, the roentgen findings were identical with the picture of Scheuermann's cases and in addition showed added shadows of an oblong abscess which completed the picture of the tuberculous process. In the second and third cases, the roentgenograms showed varying degrees of saddle-shaped de-

formity of the anterior borders of the vertebral bodies, condensation of the margins of the bodies, and at the time of the early examinations, indistinct anterior borders of the bodies. The author did not consider these findings as typical of Scheuermann's kyphosis. He thinks they are due to an unusual form of tuberculosis.

He believes his cases, as described very completely in this paper, are interesting from a two-fold point of view, showing first, that one of the causes of the "stiff, round back" may be tuberculosis; and second, that an inflammatory process of tuberculosis of the spine may pursue a mild course for a long time, without definite clinical or roentgen evidence, and the actual condition may not be demonstrable until after a period of several years. It is obvious that all cases of round, stiff back cannot be explained as due to a latent tuberculosis, for this is only one of the causes. It has been demonstrated in recent years by Italian authors that the disturbances of the hypophysis can also produce the typical clinical picture of kyphosis adolescentium.—*R. S. Bromer.*

CONGDON, RUSSELL T. Spondylolisthesis and vertebral anomalies in skeletons of American aborigines. With clinical notes on spondylolisthesis. *J. Bone & Joint Surg.*, July, 1932, 14, 511-524.

The anatomical material on which this study is based comprises nearly 200 skeletal remains of American aborigines, obtained in the course of archeological investigations in the Columbia River region. Bilateral separation of the neural arch was found in 10 subjects. This occurred in the fifth lumbar vertebra in 9 subjects, in the fourth lumbar in one; in one of the 9 subjects, the bilateral defect occurred in both the fourth and fifth lumbar vertebrae. These subjects also in some instances showed marked changes in the structure of the first sacral body, related to changes in the accompanying fifth lumbar vertebra. In 5, in which the defective fifth was superimposed upon the first sacral segment in the position assumed during the life of the subject, definite evidence of spondylolisthesis was found.

In the living subject, existence of the defective neural arch cannot be demonstrated by the roentgen examination. When, however, spondylolisthesis is present and there is considerable space between the two parts of the divided arch, the defect may be visualized.

Its existence is suggested when the anteroposterior diameter of the vertebra involved in spondylolisthesis is greater than that of the other lumbar vertebrae, as seen in the lateral roentgenogram. Bilateral separation of the arch results in a marked instability of the lumbar spine. Congdon believes that the increasing knowledge, gained from roentgenographic examination and operative findings, indicates that this defect is the fundamental etiological factor in a rather large group of cases of spondylolisthesis.—*R. S. Bromer.*

LAWSON, JOHN D. Lateral dislocation of the vertebra. *J. Bone & Joint Surg.*, April, 1932, 14, 387-390.

Lateral dislocations of the vertebrae are still rare, few having been reported in the literature. Lawson reports 3 cases:

1. A lateral dislocation of the fourth lumbar vertebra upon the fifth.
2. A fracture of the body of the twelfth dorsal; marked narrowing of the eleventh intervertebral disc; lateral dislocation of the twelfth upon the eleventh, the displacement being approximately three-fourths of an inch.
3. Fractures of the transverse processes, left side, of the first, second, third, fourth and fifth lumbar vertebrae; fractures of the transverse processes, right side, fourth and fifth lumbar; transverse fracture of the sacrum extending from the lumbosacral joint laterally to the sacroiliac joint on the left; fracture of the tip of the fifth lumbar spinous process; lateral dislocation of the fifth lumbar on the first sacral vertebrae.

The case histories are illustrated with roentgenograms of the three patients.—*R. S. Bromer.*

KLEINBERG, SAMUEL. Unilateral subluxation of the lumbosacral joint. *J. Bone & Joint Surg.*, April, 1932, 14, 384-386.

Kleinberg's case is that of a patient complaining of persistent back disability after a trauma of a back wrenching nature. Non-stereoscopic roentgenograms showed a change in the relations between the fifth lumbar vertebra and the adjoining fourth lumbar and the sacrum. Less of the fifth lumbar could be seen on the right side than on the left. The right lumbosacral articulation was not visible, while the left was clearly outlined. Stereoscopic films revealed a definite lesion. The fifth lumbar ver-

tebra was rotated forward on the right side and the articular processes were one in front of the other instead of lateral to each other as on the left side. The rotary dislocation of the fifth lumbar, Kleinberg believes, accounts for the flattening in the right lumbar area on clinical examination, the sensitiveness to pressure, the painful limitation of motion, and the disability of which the patient complained.—*R. S. Bromer.*

WILLIS, THEODORE A. Backache; an anatomical consideration. *J. Bone & Joint Surg.*, April, 1932, 14, 267-272.

Willis states that the human back is particularly subject to aches of muscle, joint and ligamentous origin because of its complicated structure, its adoption of the upright posture, and because of its frequent defects of development in the lumbosacral area, some of which are serious mechanical faults. Because of its complicated structure, careful anatomical study is necessary for the explanation of many cases of backache. At points where the normal curves of the spine meet, the back is particularly liable to strain and irritation from any source, with resulting sprain or arthritis. Exaggeration of the curves from habit, fatigue, or other cause increases such liability.

Willis discusses the following anomalies of the spine and their relation to backache: variations in the number of presacral vertebrae, variations in the number of rib-bearing segments, occasional appearance of half vertebrae, irregular fusions of segments. Asymmetrical sacralization and defective lumbosacral articulation are of definite interest only as they provide points of lessened resistance to the stresses of function, with susceptibility to muscle and ligament injury. The presence of this anomaly, as demonstrated by the roentgen ray, does not solve the problem of pain in the back and is not in itself an indication for operation. Separate neural arch is a condition which has long been recognized but its frequency of occurrence and clinical importance have not been generally recognized. Its relation to spondylolisthesis is now well known. It is the result of defective ossification of the vertebrae. Symptoms of this condition are those of ligamentous injury, acute or chronic, and referred pain. Until actual displacement takes place, the roentgen evidence is usually lacking.—*R. S. Bromer.*

POMERANZ, MAURICE M. Intrapelvic protrusion of the acetabulum (Otto pelvis). *J. Bone & Joint Surg.*, July, 1932, 14, 663-686.

Pomeranz defines the condition which he describes in his paper as a non-traumatic, chronic progressive arthritis of the hip joint, characterized by intrapelvic protrusion of the acetabulum and head of the femur. This lesion was recognized by Otto in 1824, and although occurring infrequently, is of considerable importance to orthopedic surgery and obstetrics. Variations in the pathological findings and in the wide range of etiological factors have occasioned a wide difference of opinion in regard to the disease. An overwhelming majority of writers, Pomeranz states, believe it is not a disease entity, but rather the end-result of an inflammatory process. Some regard it as a juvenile osteoarthritis or other chronic deforming process, the deformity being manifested years after recovery from the original acute infection. Numerous bacterial agents have been believed to be concerned in the process, including the tubercle bacillus, the gonococcus, the streptococcus, etc. From an etiological standpoint other conditions such as tabes, lues, metastatic malignancy, the arthritides, gouty diathesis, coxitis, chondrodystrophy, and trauma have been considered.

In incidence, it is twice as common in females as in males. Persons in middle life are usually affected, there being only one reported case at an advanced age and several under twenty years. In 49 of the 79 reported cases the condition was unilateral. The chief complaint is that of a slowly progressing painful coxitis, with the development of a limp, the patient finally assuming a wobbly gait and ultimately finding it impossible to spread the limbs or to stoop. Abduction and rotation of the femur is distinctly limited.

The diagnosis even in early cases may be made by the roentgen examination. The acetabulum projects into the pelvis as a rounded, globular, dome-shaped mass. The degree of protrusion varies from a few millimeters to 4 or 5 centimeters in severe cases. As the acetabulum migrates, it inclines upward, inward, and forward, so that it may project above the ramus of the pubis, spreading towards the obturator fossa and at times materially encroaching upon and constricting it. In extreme cases, the protrusion extends up to the sacroiliac joint and, as a result, unilateral constriction of

the pelvis occurs. The inner wall of the acetabulum may be shell-like in thinness or else it may show as an extremely dense, eburnated wall. As it extends into the pelvis, a low-grade osteoplastic process is initiated, whereby nature splints the yielding joint by the formation of a dense wall on the inner aspect of the acetabulum parallel to its projecting margin. The external margins of the acetabulum project outward over the neck of the femur as irregular serrated vegetative formations. In the typical deformity, there is preservation of the integrity of the femoral head. This would seem to be a necessary prerequisite, since the femoral head must maintain its boring qualities. Occasionally, there may occur slight deviations from the general configuration of the head; thus it may appear mushroomed, or at other times slightly elongated, with a spear-like or pear-like shape. Bone excrescences sometimes extend over the femoral neck. The constricted acetabular inlet, combined with the osteophytic projections of the head, effectually locks the femoral head within the acetabulum. As the femur follows the receding acetabulum, there appears to be foreshortening of its neck, a change, however, more apparent than real. As the head of the femur is submerged within the acetabulum, the trochanters approach the lateral margins of the pelvis and incline posteriorly. The great trochanter impinges on the ileum and the lesser trochanter approaches the ischium; thus the femur cannot be rotated outward or backward. The arrest of the trochanters at the lateral margins of the pelvis limits the deformity and further migration of the femur is impossible. The periosteum on the inner wall becomes ossified.

Pomeranz reports 6 cases. He discusses the etiology, and concludes that it seems advisable to recognize two different classes of intrapelvic protrusion: an acute type probably infectious in origin, and a chronic type occurring in the course of any disease, resulting in an osteomalacia of the hip joint. In the first case if the infection or inflammation has involved essentially or accidentally the acetabular surface of the hip joint, the femoral head remains intact and protrusion quickly develops. If the infection is severe and involves the head of the femur and the acetabulum, there is necrosis of the head and bony ankylosis may result before the deformity occurs. The second type may occur in polyarthritis and in general osseous diseases, such as syphilis, osteomalacia and Paget's dis-

ease. In this instance, the lesion in the hip is but an incident in the general deformity. In many reported cases there is evidence of an arthritic process elsewhere, commonly in the sacroiliac joint and the spine, and often in the knees, elbows and wrists. Pomeranz asks, "Is not the Otto pelvis an atypical but essentially non-specific arthritis of the hip joint?" and suggests that we abandon the conception of the specificity and individuality of this lesion.—*R. S. Bromer.*

CARY, N. AUSTIN, and BARNARD, LEONARD.
Arthrokataclasis of the hip joint. *J. Bone & Joint Surg.*, July, 1932, 14, 687-689.

In 1929, Verrall reported a case in which the lesion presented a sinking-in of the acetabulum, resulting in limitation in movement of the hip joint. He suggested the name "arthrokataclasis," meaning literally "subsidence of a joint," and suggested that it may be a localized osteomalacia. He drew attention to the fact that there was no narrowing of the pubic arch as seen in true osteomalacia. The authors present 2 cases which they believe belong in this group. In the first case the roentgen examination showed a sinking-in of the left acetabulum into the pelvis, with thinning of the acetabular floor. The head of the femur, which was enlarged, was thoroughly engaged in the center of the acetabulum. In the second case the examination showed a localized dislocation of the acetabulum and the head of the femur, much more marked on the left side, with the neck apposing the rim of the acetabulum which accounted for the limitation of motion which was demonstrated clinically.

Hertzler has described a pathological condition of the hip joint under the title, "osteoarthritic protrusion of the acetabulum." Cary and Barnard prefer the term "arthrokataclasis" as they believe it more correctly describes the condition.—*R. S. Bromer.*

SNODGRASS, L. E. Perthes' disease. *J. Bone & Joint Surg.*, April, 1932, 14, 314-324.

Snodgrass states that the purpose of his paper is: (1) to present the record of an unusual case of Perthes' disease with roentgenograms; (2) to stress an intermediate type of deformity between coxa plana and the normal hip; (3) to call attention to the similarity of the reported findings in Perthes' disease to those found in normal bone repair; (4) to point out a mechanism whereby the stability in these hips is increased; (5) to discuss briefly the etiology of the condition.

His study is based on 36 cases of Perthes' disease, and on 6 cases which showed moderate flattening of the socket with or without slight flattening and lateral displacement of the epiphysis of the femoral head, but always with coxa valga deformity of varying degree.

(1) The case of unusual interest is one showing changes in the femoral head while the socket remained constant. This case is illustrated with four serial roentgenograms.

(2) The intermediate type of deformity is the type of hip which shows, in the roentgenogram, a rather flat socket with the femoral head and neck in a position of coxa valga, sometimes with a depression in the roof of the acetabulum and often with a slight lateral displacement of the femoral epiphysis. His 6 cases of this type have all been observed for at least three years without the development of coxa plana, although one case entered the out-patient department with a complaint of pain in the hip. These subnormal hips represent an intermediate type of deformity between the normal hip, on the one hand, and the mushroom type of coxa plana, on the other. A series of films containing a film each of a normal hip, a subnormal hip, a mushroom type of coxa plana, a capped type of coxa plana and a congenital dislocated hip arranged in the order named, affords an interesting study in acetabular variations.

(3) Snodgrass states that he is not in harmony with the view of Lippmann that the histopathologic changes in Perthes' disease probably represent the result of an aseptic infarction in the femoral head area. On the contrary, he is impressed with the similarity of Lippmann's findings to some of the reported changes in normal bone repair in men and animals. If the more recent work which has been done in bone repair is accepted, the theory of vascular occlusion is unnecessary in the explanation of the findings in Perthes' disease as recorded by Lippmann.

(4) If the view is accepted that the acetabula of these subnormal hips are flattened and widened from birth, then the question arises as to why these hips do not commonly dislocate under the stress and strain of active childhood. In the development of coxa plana, the shortening of the neck and the straightening of the head and neck into a coxa valga destroy the short

arm of the lever—the head and neck at an angle of approximately 127° to the shaft of the femur—which with internal rotation, is so productive of dislocation in the normal hip. There is a resultant increase in stability, for the joint is adjusted to withstand the extremes of internal rotation, flexion and abduction.

(5) One of the first theories of etiology was the infectious, but after almost twenty years of effort by careful workers no organism has been demonstrated consistently in this condition. The theory of vascular occlusion with infarction does not carry the weight it did before the more recent studies in bone repair were made. Likewise, the rather strictly limited age incidence for the disease is not easily explained by infection or vascular occlusion. The belief, expressed by some, that the head flattens the acetabulum, disregards the screw-like action of the hip as shown by Walmsley. He demonstrated that the arrangement of the fibers in the capsule of the joint tends to force the head with a screw-like motion into the socket in extension which is the normal weight-bearing position. If Walmsley's observations are correct, one would expect a deepening effect on the socket by the femoral head, even though flattened.

Snodgrass states that if the bone changes in the femoral head are assumed to be examples of normal bone repair in an area of injury caused by a flattened socket, the question of what institutes the process still remains unanswered. The irritation produced by the incongruity of the parts might produce a local hyperemia which would yield a rarefaction of the femoral head of sufficient degree to permit a crushing fracture by body weight. External trauma might initiate the same course of events in a shorter period of time.—*R. S. Bromer.*

LAPIDUS, PAUL W. Longitudinal fractures of the patella. *J. Bone & Joint Surg.*, April, 1932, 14, 351-379.

The purpose of Lapidus in this paper is to call attention to longitudinal fractures of the patella. These fractures, although thought to be a great rarity are, in his belief, rather common and as a rule unrecognized. Transverse fractures of the patella are common. The literature on longitudinal fractures is scarce. Roentgen rays have greatly helped in the recognition of the fracture. He reports 12 cases profusely illustrated with roentgenograms. Correct diagnosis is important for the purpose of proper

treatment, especially in legal cases. The clinical picture is clear cut: history of injury, localized linear tenderness over the lateral border of the patella, effusion in the knee joint (usually hemorrhagic), comparatively negligible disability. Lapidus thinks that in the majority of his cases there must have been a combination of direct violence with the indirect action of muscular pull.

It is important to remember that the usual routine method of roentgenography of the knee, anteroposterior and lateral views, does not as a rule show a longitudinal fracture of the patella, largely because of the superimposed image of the femur over the patella in the anteroposterior view. Lapidus employs a technique consisting of a series of views: anteroposterior; oblique with the knee slightly rotated externally about 15° , while the patient lies on his abdomen with the film beneath the patella; oblique in certain cases with internal rotation of the knee; and, finally, a view made with the patient on his abdomen, the film placed beneath the lower end of the femur while the knee is flexed as sharply as possible. The tube in this last position is tilted so that the central ray passes parallel to the articular surface of the patella between it and the condyles of the femur, directed upward from the leg to the thigh. This view may also be made with the patient kneeling on the film. The leg is flexed at the knee as much as possible without discomfort. The tube is tilted, fixing the central ray the same as in the previously described technique, between the patella and the condyles of the femur, but in reversed direction—from the thigh toward the leg. Both patellae may be taken on one film in the same exposure, the central ray being directed between the closely approximated knees, while both legs are flexed at the same angle. If in some cases in very recent longitudinal fracture with considerable effusion, it is difficult to flex the knee, aspiration of the knee joint should be performed before the roentgen examination. Lapidus recommends that in the lateral oblique position, the central ray be directed through the head of the fibula. This gives a clear picture of the lateral part of the patella without superposition of the shadow of the femur.

Congenital malformation of the patella may easily be mistaken for longitudinal fracture, and should always be considered in the differential diagnosis. Bipartite or multipartite patellae are not so extremely rare. A more or less marked

defect over the upper outer border of the patella often occurs. The patella may ossify from two centers, the place of fusion being a site of lessened resistance. Trauma, causing separation of the fusion between the two centers of ossification, may give the appearance of a patella bipartita. The location, size and shape of the fragments may be of some aid in the differentiation of longitudinal fracture from congenital anomalies. In most cases of such fracture the outer fragment is larger than in cases of malformation, and the line of fracture usually runs over the junction of the middle and the outer quarters in a vertical direction. The accessory center of ossification is smaller in the majority of cases, as compared with the main part of the patella, and is usually located over the outer upper part of the patellar border, the condition being usually bilateral and symmetrical. The history of injury associated with the other findings, suggesting the traumatic nature of the lesion, is of importance in the differential diagnosis. Injuries of the knee joint with a pre-existing congenital anomaly may sometimes make the precise diagnosis difficult. It is especially important in compensation and legal cases, to have as a routine, the roentgenograms of the healthy patella for comparison.

Therapeutic value of repeated aspiration of the effusion in the knee joint is emphasized in these cases. Longitudinal fracture may lead to a quite prolonged disability if overlooked. If properly recognized and treated, complete recovery within six to eight weeks may be expected. No operative treatment should be employed.—*R. S. Bromer.*

COLEY, BRADLEY L. Echinococcus disease of bone; report of two cases involving the pelvic girdle. *J. Bone & Joint Surg.*, July, 1932, 14, 577-590.

Hydatid disease of the skeletal system is an extremely rare bone lesion. Coley reports 2 cases with involvement of the pelvis in each case, the roentgenograms being reproduced in the article. While relatively uncommon in the United States, hydatid disease has received intensive study in the countries where it is of frequent occurrence. In most countries osseous hydatid is considered a surgical curiosity. Of the bones involved, Walker and Cummins have shown that the pelvic girdle is the most frequent site of invasion, although cases have been reported involving practically every part

of the skeleton. The question has been raised as to the probability of direct invasion from the pelvic peritoneum by the frequency of involvement of the bones of the pelvic girdle. Coexistent visceral and bone involvement is rare. The epiphyseal ends of the long bones seem to afford a site of predilection for the parasite, and it is now generally accepted that it is lodged in the bone by way of the blood stream.

The development within the bone is essentially slow and free from symptoms, and it appears to exhibit its greatest latency in osseous tissue. Pain, as a late phenomenon, usually follows some complication, such as infection or fracture. Loucks wonders that a high percentage of metastatic lesions has not been described for bone hydatid cysts, and in those cases, particularly where there has been a fracture, so that an opportunity has been afforded for the circulation of the viable elements of the organism by way of the ruptured vessels. In one reported case, secondary pulmonary cysts followed pathological fracture of the ileum.

Roentgenographic examination, according to Leborgne, in the early period of the disease reveals one or many small cystic areas, like bunches of grapes, rounded, punched out, sharply outlined, but without the reaction of condensing osteitis, i.e., without new bone formation at the periphery. At a later period when the bony enlargement is perceptible on palpation, alteration in the contour of the bone is observed, in the nature of a fusiform expansion without any sort of new bone formation. The bone is seen reduced to a shell under the periosteum which may be broken through spontaneously. The bony swelling has a typical, areolar appearance, infiltrated by large cavities of more or less irregular contour, but discretely outlined. The absence of bone hyperplasia classifies the lesion among the rarefying osteopathies and rules out osteomyelitis. Bone syphilis or gummatous conditions are encircled usually with a limiting ring of new bone formation. Central osteosarcomata, such as round cell or spindle cell, usually have a different clinical setting. In the differentiation of von Recklinghausen's disease, the rarefying areas have usually more clearly cut outlines in hydatid disease. In addition, osteitis fibrosa cystica usually involves other portions of the skeleton. Isolated bone cysts offer more diffi-

culty in differentiation. In the 2 cases here reported, the diagnosis was not made from clinical or roentgenographic studies but from the pathological examination. The disease can simulate roentgenographically a variety of bone conditions.

Intensive radiation therapy failed to check the disease or to alleviate the symptoms in Coley's cases.—*R. S. Bromer.*

DAVIDSON, ARTHUR J., and KURTZ, ARTHUR D. Giant-cell tumor (sarcoma?) of the astragalus. *J. Bone & Joint Surg.*, April, 1932, 14, 410-411.

Davidson and Kurtz report a case of giant cell tumor of the astragalus following a traumatism of the left foot and ankle. On roentgen examination, on admission to the hospital, a diagnosis of crush fracture of the posterior third of the astragalus was made, the astragalocalcaneal joint being obliterated in the area of fracture. Astragalectomy was performed and the roentgenographic diagnosis was confirmed when the astragalus was exposed. But when traction was made upon the head of the astragalus to dislocate it outward, the entire bone collapsed into a number of fragments. Extreme thinning of the shell of the bone was observed, the internal structure being replaced by soft hemorrhagic tissue, with lighter areas of granulation tissue in it. Then, and then only, was tumor formation suspected. The laboratory report of the excised portions of the astragalus stated that the histological structure in the bone was that of a typical, benign giant cell tumor, except that in small areas there was more connective tissue present and fewer giant cells and many mitotic figures. It had many characteristics of a malignant lesion, and for this reason, it was not considered as entirely benign.—*R. S. Bromer.*

MILTNER, LEO J., and WAN, F. E. Giant-cell tumor of the os calcis. *J. Bone & Joint Surg.*, April, 1932, 14, 406-409.

The authors report a case of giant cell tumor of the os calcis. This is a rare condition. Moore, in a recent survey of the literature, could collect only 4 cases, to which he added 3 more, found in a study of 1,740 bone tumors. Roentgenograms showed expansion of the os calcis in all directions, particularly on the lateral side. The cortex of the bone was apparently intact. The surface articulating with the astragalus

appeared irregular and slightly absorbed. Numerous cystic spaces with intervening areas of condensation were seen inside the expanded bone. The microscopic diagnosis after operation was giant cell tumor with cyst formation.

The operation performed consisted of complete removal, through a wide "V"-shaped incision. The tendo achillis was lengthened and its lower end was fastened to the posterior-inferior part of the astragalus through drill holes in the latter. The foot was held in 45° plantar flexion during the tendon lengthening and, following closure of the wound, a long leg cast was applied with the ankle in the same position.

Concerning the prognosis for the function of the foot, the authors believe that if a calcaneal deformity develops at a later date, correction may be accomplished by posterior transplantation of the peroneus longus and tibialis anticus tendons. In the event that this should fail, permanent stability could be obtained by arthrodesis of the ankle and mid-tarsal joints.—*R. S. Bromer.*

BLOOD AND LYMPH SYSTEM

POPP, L. Despre radiodiagnosticul arteriosclerozei periferice in legătură cu un caz de dysbasia intermittens angiosclerotica Erb, vindecată subiectiv prin diathermie. (Roentgen diagnosis of peripheral arteriosclerosis in connection with a case of dysbasia intermittens angiosclerotica Erb subjectively cured by diathermy.) *Cluj. med.*, Nov., 1931, 12, 587-588.

Calcification of the peripheral blood vessels is often observed in routine roentgenograms of the extremities. According to the author's estimation, a diagnosis of arteriosclerosis should not be made in such instances unless there are other clinical symptoms present. He recently observed a case of calcification of the arteria dorsalis pedis and of the arteria tibialis posterior of the right lower extremity in an old diabetic fifty-five years of age, who suffered from dysbasia intermittens angiosclerotica Erb. A dietetic regimen associated with 20 seances of medical diathermy resulted in disappearance of the symptoms, the patient remaining well for over five years. The calcification of the peripheral vessels which was observed at the original examination remained the same, indicating that the symptoms were probably due to angiospasm of the smaller non-calcified vessels. The

RÓZSA, STEPHAN. 10 Jahre Strahlenbehandlung des Sarkoms. (Ten years' radiotherapy of sarcoma.) *Strahlentherapie*, 1932, 43, 719-726.

From 1920 to 1930, 129 sarcomas have been treated by radiotherapy in the roentgen section of the Municipal Hospital of Stettin. The number of patients alive and well after five years is 14.6 per cent of the whole number and the number of three-year cures 22 per cent. These results are practically the same as those of other authors. The treatment of sarcoma still remains chiefly surgical. Küttner obtained 30 per cent permanent cures by surgery and this figure has not yet been equalled by radiotherapy. An attempt at radiotherapy should be made before performing severe mutilating operations.

In certain sarcomas, such as sarcoma of the tonsils and the nasopharynx, radiotherapy is apparently superior to surgery and in gland sarcomas it is of equal value. The results are not bad in sarcomas of the pleura, sarcomas of the uterus and in postoperative recurrences in sarcomas of the jaw. The results have not been improved even with large doses and Pfahler's saturation method but final judgment cannot yet be passed on this method.—*Audrey G. Morgan*.

ROFFO, A. H. Durch radium vernarbtes Röntgenkarzinom. (Roentgen carcinoma healed by radium treatment.) *Strahlentherapie*, 1932, 43, 757-766.

Many roentgenologists have died of roentgen carcinoma. In most cases surgery has been used without effect. It has generally been believed that further irradiation would make the condition worse but the author says this is a mistaken conception. When epithelial cells become neoplastic their biology changes and they react to rays just like any skin cancer. In support of this statement he describes a case of roentgen carcinoma in a colleague, Dr. Lucio A. Aravena, treated and healed by radium irradiation. Dr. Aravena began his work as a roentgenologist in 1904 when very little was known about protection from the rays. Soon a roentgen dermatitis developed which gradually developed into ulcers. He suffered intense pain and finally had to give up his work and all use of hands. By 1928 the ulcers had become distinctly carcinomatous. Dr. Roffo advised radium treatment. Molds were made of Colum-

bia paste and adapted to the different fingers, also to enlarged ganglia at the elbow. The dosages for the different ulcers are given. The left index finger was the worst; it was ulcerated all over, was twice its normal size and the nail bed was transformed into a suppurating ulcer. It was treated by means of a plate containing 12 tubes of 10 microcurie-hours each mounted on an apparatus of Columbia paste. Diameter 7 mm., filter 1.5 mm. platinum, 192 irradiation hours; dose 23.04 mc.

Within two months the ulcers had all healed and now after a year they remain so.—*Audrey G. Morgan*.

PICCHIO, CARLO. La roentgenterapia a dosi frazionate e protratte. (Roentgen therapy in protracted fractional doses.) *Radiol. med.*, Jan., 1932, 19, 1-38.

The author discusses the results of a year's experience with protracted fractional irradiation by Coutard's method. He finds that with this new technique improvement can be brought about in forms of tumors that were very little or not all affected by the previous methods. He discusses the biological and physical reasons for the advantages of this method and emphasizes the importance of a proper time distribution of the dosage which gives the radiation an elective action on the neoplastic tissue and spares the normal tissue to a remarkable degree. The rays applied by this method have a great penetrating power but they are absorbed very little by the superficial tissues. For this reason large doses can be used without danger of injuring the skin.

Some limitations of the method are also discussed. It cannot be applied to all forms of tumor for technical reasons and on account of its expense.—*Audrey G. Morgan*.

FAUST, HERBERT. Nachgewiesene schwere Schädigung des Perikards nach Röntgentiefenbestrahlung der Präkordialgegend. (Severe injury of the pericardium after roentgen deep irradiation of the precordial region.) *Strahlentherapie*, 1932, 43, 749-756.

A boy of sixteen went to Professor Werner of Heidelberg for treatment in 1927. Roentgen examination showed a round tumor of the mediastinum for which he was given 1/10 of a skin erythema dose five times in the course of four days. Some months later he came to the author. His symptoms had grown worse. On

the basis of another roentgenogram a diagnosis of mediastinal tumor was again made. He was given four irradiations of 30 per cent of a skin erythema dose over three fields, anterior, posterior and lateral at the level of the tumor; fields 10×15 cm., focus-skin distance 40 cm. 36 per cent depth dose, 0.5 mm. zinc and 1 mm. aluminum filter, half-value layer 0.8 mm. copper. After five months he was given a second series of deep roentgen irradiations of the same kind. The tumor shadow decreased two fingers breadths. Re-examination in July, 1930, showed the same findings. In March, 1931, he was given 40 per cent of a skin erythema dose twice on back and chest. The size of the tumor decreased still further. In November, 1931, he came back in much worse condition. The heart and mediastinal tumor were much enlarged and there was a heart-shaped figure inside the "tumor" shadow, indicating pericarditis. Puncture showed clear yellow fluid. The patient was again given 30 per cent of a skin erythema dose twice. His condition continued to grow worse. Another puncture did not yield any fluid but only masses of fat and sebaceous material such as are seen in dermoid cysts. A diagnosis of dermoid cyst was now made and operation performed but the patient died two hours later. Autopsy showed a dermoid cyst the size of a man's fist in the right mediastinum and an extensive fibrinous pericarditis.

Exact roentgen diagnosis of mediastinal teratoma is very difficult. If there is a round, sharply outlined shadow in the mediastinum which shows no pulsation and does not move with respiration in a young patient at about the age of puberty or a few years after, teratoma or dermoid cyst should be suspected and an attempt made to obtain material by puncture from which a histological diagnosis can be made.—*Audrey G. Morgan.*

CASPARI, W. Die Bedeutung der unspezifischen Immunität für die Krebstherapie. (The importance of nonspecific immunity in cancer therapy.) *Strahlentherapie*, 1931, 42, 899-913.

Nonspecific immunity can be brought about in various ways, best by the introduction of living cells into the body; the products of catabolism of the cells, particularly the albumin substances bring about immunity reactions

The same biological process takes place when the cells of malignant tumors are broken down spontaneously in the body. The pathological process itself brings about counter-reactions in the body. The author calls these substances which are produced by catabolism of the tumor tissue necrohormones.

The process called nonspecific immunity probably consists of a direct or indirect stimulation of the reticulo-endothelial system.

Nonspecific immunity helps in recovery from cancer after operation. Whenever an individual has a large tumor there are probably cancer cells scattered through the organism. They need not necessarily be macroscopically demonstrable metastases. The natural defensive forces of the body are stimulated to overcome these foci by the operation, partly by detoxication and probably also partly by blood-letting. The author questions whether in tumor operations it is necessary to avoid bleeding as thoroughly as modern surgeons generally do.

Postoperative irradiation also helps to bring about nonspecific immunity. He is inclined to agree with those who advocate small doses. Too large local doses may paralyze the reaction of the reticulo-endothelial system instead of stimulating it. Non-specific immunity is best stimulated by general irradiation of the body with small doses. The effect of irradiation depends on the reactive capacity of the reticulo-endothelial system. If it is in good condition and capable of reacting vigorously there will probably be a temporary paralysis followed by compensatory hypertrophy. But if it is in bad condition, as in cachexia, the same concentration of necrohormones will injure it still more.

The author has succeeded in bringing about immunity in animal experiments by ligating the hilus of the spleen. Spleen cells are broken down and specific necrohormones enter the circulation and bring about an intense histiocytic reaction. It is possible that this method can be used in man also. Some authors are trying the effect of heat in bringing about nonspecific immunity. Coley has recently reported good results in cancer from the use of the malaria treatment introduced by Wagner-Jauregg for the treatment of paresis. The methods of nonspecific immunity are at least worthy of further study in the treatment of cancer.—*Audrey G. Morgan.*

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